SOME STUDIES ON RURAL WATER SUPPLY SCHEMES

A Thesis Submitted
in Partial Fulfilment of the Requirements
for the Degree of

MASTER OF TECHNOLOGY

By

R. P. YADAV

to the

DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY KANPUR

MAY, 1980

DEDICATED TO THE SWEET MEMORY OF

MY PARENTS

CERTIFICATE

This is to certify that the thesis 'Some Studies on Rural Water Supply Schemes' submitted by Mr. R.P. Yadav in partial fulfilment of the requirements for the degree of Master of Technology of the Indian Institute of Technology, Kanpur, is a record of bonafide research work carried out by him under my supervision and guidance. The work embodied in this thesis has not been submitted elsewhere for a degree.

Dated: May, 1980

K. Subramanya

(K. SUBRAMANYA)
Professor
Department of Civil Engineering
Indian Institute of Technology, Kanpur

ACKNOWLEDGEMENTS

I had a pleasurable and stimulative environment in which I carried out this project under the supervision of Dr. K. Subramanya, Professor, Department of Civil Engineering, Indian Institute of Technology, Kanpur. I express my hearty gratitude and deep regard to him for his invaluable guidance, help, interest and encouragement.

Thanks are due to Shri O.P. Bishnoi, Chief Engineer (Project and Design), Shri S.K. Singh, Research Executive Engineer and Shri M.K. Shukla, Executive Engineer, of U.P. Jal Nigam for their kind help to provide me the reports of few rural water supply schemes and other details regarding the same.

I am also thankful to Mr. R.S. Chaudhary, Mr. S. Das Gupta and all my friends who have helped me with keen interest to bring out this project.

I wish to express my appreciation to Mr. G.S. Trivedi for his nice typing, Mr. J.C. Verma for his fine drawing and others of Civil Engineering Department for their valuable cooperation.

R.P. YADAV

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

Symbols

C	Hazen Williams Roughness Coefficient
γ	Specific Weight
γ_w	Specific Weight of Water
S	Specific Gravity

Abbreviations

WHA	World Health Assembly
LSGED	Local Self Government Engineering Department
IDA	International Development Authority
LIC	Life Insurance Corporation
RWSS	Rural Water Supply Scheme
RWS	Rural Water Supply
l.p.c.d.	Litres per capita per Day
A.C.	Asbestos Cement
P.V.C.	Polythene Polyvinyl Chloride
G.I.	Galvanized Iron
C.I.	Cast Iron
B.H.P.	Break Horse Power
UNICEF	United Nations International Children's Emergency Fund
NWSP	National Water Supply and Sanitation Programme
O.H.T.	Over Head Tank

RCC	Reinforced Cement Concrete
KL	Kilolitre
PSIG	Per Square Inch Gauge
MGD	Million Gallons Per Day
GPM	Gallons Per Minute
CFS	Cubic Feet per Second
l/s	Litres per Second
LP	Linear Programming
HGL	Hydraulic Grade Line

ABSTRACT

The rural water supply schemes of U.P. Jal Nigam have been studied by taking five representative projects. The present studies of design criteria and the overall typical characteristics of these water supply schemes have been highlighted. The need for an efficient design and analysis of water distribution networks has been brought out.

A versatile water distribution network system analysis programme has been implemented at I.I.T. Kanpur DEC 1090 system. The five selected rural water supply schemes were analysed through the use of this versatile programme. The deficiencies in the existing schemes and the methods to modify them have been indicated.

A method for the optimum design of tree type water distribution network has been indicated.

1 INTRODUCTION

1.1 GENERAL

Water, like air, is essential to human survival, so it is a must for a welfare government to provide safe and potable drinking water in adequate quantity to its urban as well as rural population. In recent few years there is a progressive effort towards this.

The United Nations Water Conference held at Mar del Plata, Argentina, in March 1977 recommended that the decade (1980-1990) should be designated as the 'International Drinking Water Supply and Sanitation Decade'. The resolution WHA 30.33 concerning preparations for the decade (1980-1990) has been unanimously adopted by the thirtieth World Health Assembly in May 1977. According to this (i) Implementation of National Plans for drinking water supply and sanitation to all urban and rural communities should be increased, (ii) Specific targets should be set up by each country taking into consideration its sanitary, social and economic conditions[20]. The above is an important resolution and it is but natural that the Central and State Governments of India will give high priority for drinking water supply and sanitation programme, and provide necessary provisions in the annual plans so as to achieve these objectives.

According to the World Health Statistics Report, 1976, about 77 percent of the urban communities and 22 percent of the rural communities among the developing countries have been provided with adequate water supply upto 1975. Progress in urban water supply in India is comparable to that at global and South East Asia regional level, but it is rather poor in rural water supply systems. In India 60 percent of the urban community and 4 percent of the rural community was served by water supply facility in 1970 and 79 percent and 18 percent in 1975 respectively, as indicated in Table 1.1.

TABLE 1.1 WATER SUPPLY POSITION IN INDIA

Community	Population served (percent)		Population to be served (Target) (percent)	
	1970	1975	1980	1990
Urban	60	79	98	100
Rural	4	18	32	100

As per 1971 Census the country had an urban population of 1090.94 million spread in 3,119 towns and rural population of 438.58 million in 5,75,936 villages and hamlets. The population in 3,18,633 villages (55.32 percent) is less than

500. An additional 1,32,990 villages have population in the range of 500-999 making a total of 4,51,626 (78.41 percent). These villages are scattered in the countrysides, some of which are inaccessible during part of the year whereas some have no reliable source nearby. A total of 1,52,475 villages came under the category of scarcity or problem villages, which pose a challange to those involved in water supply programme.

Water with high chemical ingradients such as fluorides, chloride, iron and manganese have been found in about 25000 villages with a population of approximately 21.93 million. In addition water borne diseases such as dysentery, gasto enteritis, infectious hepatitis, enteric fevers and poliomylites are prevelent in urban and rural areas. The death rate due to these diseases have been found to be 9.6 and 16.5 per thousand persons in urban and rural communities respectively. This reflects an urgent need of safe water supply and other public health facilities, especially in rural areas.

Out of the total annual precipitation of 400 million hectare meter, only about 105 million hectare meter is estimated to be ultimately utilizable containing of 70 million hectare meter of surface water and 35 million hectare meter of ground water. The surface water is not safe as it gets

polluted due to increased industrialization. In ground water there is presence of chemical ingradients. So, there is a need of some technological solution for safe water supply. These are the reasons why India Government is giving more emphasis on rural water supply schemes, from Fourth Five Year Plan (1969-74). The accelerated water supply programme gave a further boost to rural water supply. About 64,000 out of 5,75,936 villages and 1,890 out of 3,119 towns have been provided with water supply by 1978. The outlay on rural water supply was 0.8 percent of the total plan during the first plan which increased to 1.5 percent in the fifth plan. The annual per capita expenditure on rural water supply and sanitation for the unserved population of the entire country was increased from Re 1.00 from the fourth plan to Rs. 2.4 in the fifth plan (1974-1978).

Several financing institutions like the Life Insurance Corporation of India and Banks have been providing part of funds required for water supply schemes. Funding from international and bilateral agencies are available now.

1.2 U.P. JAL NIGAM

Previously supplying of water to a community was the responsibility of the municipal authorities. But when the work grew in complexity and volume, need for the establishment

of a seperate organisation was felt and in 1927, the U.P. Public Health Engineering Department was created. It was later re-named the Local Self Government Engineering Department (LSGED) which is now fully merged in the U.P. Jal Nigam. Further, State Government gave more emphasis on water supply and sanitation which required large initial investment. So, in the seventies the World Bank was approached. But to give financial assistance it wanted a central organisation with statutory powers to be established first, through which loans to the local bodies could be channelized. Due to this the State Government created an organisation named U.P. Jal Nigam on June 18, 1975 by an act of U.P. Legislature. Now it is a dynamic organisation of U.P. Government, which is working under the financial assistance mainly of International Development Authority, (IDA), a subsidiary of the World Bank for soft lending to member nations of United Nations Organisation for development programmes; the Dutch Government and the Life Insurance Corporation of India (LIC)[7].

It consists of eight Jal Sansthans, three Regional Jal Sansthans namely Garhwal, Kumaon and Bundelkhand and five local Jal Sansthans for KAVAL towns ie. Kanpur, Agra, Varanasi, Allahabad and Lucknow to give proper water supply and sewerage facilities.

During the five Five-Year Plans only 6,670 villages were brought under the piped water supply. Out of the 1,12,561 revenue villages in the state 35,506 villages suffer from scarcity of potable water. Similarly outof the 619 urban localities barely 376 localities had piped water supply. Till the end of the Fifth Five Year Plan only 39 urban localities were provided the sewerage facility. The Nigam provided water to 1,917 villages during the year 1978-79. This compares very favourably with the 6,670 villages which were provided this facility during the last five Five Year Plans, i.e. upto 1978, and that. During the year 1977-78, drinking water was provided to 1,200 villages.

During the Sixth Five Year Plan period 1978-83 it has been envisaged to provide piped water supply to all the 619 urban local bodies of the state as well as to provide underground sewerage system in 39 more towns. Strengthening of water supply has been proposed in 83 towns and sewerage reorganisation in eight towns. A target covering, 14,200 more villages has been set for rural water supply programme. To boost the progress of rural water supply schemes, the Central Government has launched a crash programme under the title, 'Accelerated Rural Water Supply Programme' and it is likely that a sum of Rs. 26 crores will be made available for this, besides the plan allocations. This will be utilised

for provision of safe drinking water supply facilities to about 2,250 additional villages.

1.3 DESIGN CRITERIA

The design criteria for the RWSS adopted by U.P. Jal Nigam with recent guidlines is as following:-

Design Period

The design period should be 30 years.

Population

The rural design population should not be estimated by the previous criterion of increasing the present population by 50 percent except the villages bordering the towns where the percentage increase in the design population may be more. Any one of the following methods is to be adopted to calculate the design population.

i) Arithmetical mean method

ii) Geometrical increase method

iii) Incremental increase method

iv) Decrease in percentage increase method

v) Graphical method

- a) an ordinary plot method
- b) a semi-log plot method

vi) Comparative method

Floating Population

The equivalent population for feeding the institution, market and mela may be considered as 20 percent of the total population.

Rate of Water Supply

(i) 70 l.p.c.d. for villages where individual design population is less than 4,000 and where private house connections are expected.

(ii) 50 l.p.c.d. for small villages where no or few hourse connections are expected.

(iii) 25 l.p.c.d. where adequate source is not available. But the schemes should be framed on 50 l.p.c.d. so that except for 2 to 3 months of the summer adequate quantity of water is available to the beneficiaries.

(iv) 90 l.p.c.d. for villages where individual design population is more than 4,000.

Source Discharge

The discharges of the source should normally be measured for three consecutive years of the driest season and the least discharge should be adopted. In the case if the scheme is to be prepared urgently, the one year driest discharge should be double than the ultimate requirement.

In special circumstances where there is an acute scarcity of drinking water the scheme can be framed if the discharge of the source can feed at a rate of 25 l.p.c.d.

Service Reservoir

Minimum storage however should not be less than 10 l.p.c.d. or 1/6th of the days requirement whichever is more.

Peak Factor

For KAVAL towns	2.0
For Urban towns	2.5
For Rural areas	2.5
For Industrial areas	1.0

These peak factors are applicable on maximum day per capita rates adopted.

Distribution System

The distribution network should be designed for peak flow of peak factor times the average demand.

The minimum size of a distribution main should be kept according to the size of the town as per following criteria.

Design Population	Minimum Size of Distribution Main
Upto 5,000	50 mm
5001 to 50,000	80 mm
50,001 to 5,00,000	100 mm
above 5,00,000	125 mm

In hills the minimum size shall be 25 mm.

For towns of population above one lac wherever the main road is more than 20 m in width, mains will be laid on both sides so that the road is not cut for service connections later on.

Pipes

Medium quality of G.I. pipes should be used for water supply schemes of hilly areas.

In plains P.V.C. pipes may be adopted upto a dia of 100 mm. A.C. pipes should be used for bigger sizes. Presently upto 150 mm P.V.C., 200 to 600 mm A.C. and above 600 mm C.I. pipes are being used.

Terminal Pressures

Terminal pressures shall be provided as listed in the following tablar shape.

Design Population of the town(in lacs)	Building type	Terminal Pressure (m)
Upto 0.20	Single storied	7
	Double storied	12
0.20 to 0.50		
0.50 to 1.00	No consideration of the height of building	12
1.00 to 5.00		
5.00 to 10.00		
above 10.00	No consideration of the height of building	15

Terminal pressure for villages shall be 7.0 meters. Minimum terminal pressure of 6 m for single storied buildings with market and a few house connections and 8 m for double storied building with a large number of house connections were adopted previously by Nigam.

Pipe Lines

Sluice valve/wheel valve may be provided at a spacing of 21 cms (for sizes greater than 150 mm, the spacing may be reduced as required).

Terminal pressure - Minimum 6 m

Design of distribution system are to be done for each and every village. Station pressure must be duly considered for deciding classes of pipes. Break pressure tables are to be provided as required.

Stand posts considering initial population (upper limit)

(i) One for about 150 persons in hilly areas

(ii) One for about 250 persons in plains.

There should be one stand post atleast for weaker section such as Harijan and Tribal community.

Air valve should be provided on summits.

Tank type stand posts, instead of single tap piller type previously used.

(i) In such villages where no private connections are

expected in the begining, tank type stand posts with capacities of 2000, 3000, 5000 litres may be provided, keeping in view 1/2 day's requirement in the initial stages.

(ii) The distribution system even in these villages will be designed for 6 meters, minimum terminal pressure to provide for house connections in future.

Rising Main

The economical size of rising main should be calculated as per departmental tabular procedure taking electricity tarif rule for the cost of every corporation economics of laying a size main throughout the design period to that of duplicating after 15 years be worked.

For tube wells and other pumping schemes requiring short length of rising main (say not exceeding 200 m), it would be desirable to use C.I. pipes. At other place A.C. pipe tested upto adequate pressure may be considered.

Consumption

The annual average supply of water is expected to be about 75 percent. The consumption of chemicals, electric or diesel should be calculated on this pattern. Minimum of two tube wells may be provided. The pumping hours of the tube well may generally be taken 16 hrs at the ultimate period of the scheme.

Hydraulic Gradient

To design the distribution main, such hydraulic gradient may be adopted for different type of pipe materials as to provide an economical design. For this purpose the hydraulic gradient arrived at for economic design of rising main shall be adopted. Generally the hydraulic gradient for P.V.C. and A.C. pressure pipes shall be 3 to 4 per thousand and for C.I. and steel pipes 5 to 6 per thousand. However the gradient may vary according to the minimum size of the distribution main as recommended in para 'Distribution System'.

Size of Pump House

BHP	Size
10.0	8' x 10' x 12'
12.5 to 40.0	12' x 10' x 12'

The chloronome house is to be constructed jointly with pump house as per type design.

Accomodation of the Staff

(i) For pump operator - one single room quarter with box room.

(ii) For chawkidar - one single room quarter with one box room.

Provision for more buildings is to be made after

obtaining Chief Engineer's instruction. For gravity schemes where provision of part-time staff for maintenance purposes is considered adequate, number of buildings should be provided.

List of Various Categories of Pipes and Their Working Pressures

(i) A.C. Pipes

Type of Pipe	Working Pressure
Class I	2.5 kg/cm^2
Class II	5.0 kg/cm^2
Class III	7.5 kg/cm^2

(ii) G.I. Pipes

Size (mm)	Pressure (kg/cm^2)		
	Light	Medium	Heavy
6 to 25	10.5	21.0	24.6
32 to 40	8.8	17.6	21.1
50 to 80	7.0	14.0	17.6
80 to 100	5.6	10.5	14.0
125	-	10.5	14.0
150	-	8.8	10.5

(iii) P.V.C. Pipes

These are available in 4 , 6 and 20 kg/cm^2 working pressures, M/s Wavin India Ltd. have, however, offered pipes capable of withstanding a working pressure of 5 kg/cm^2 against 4 kg/cm^2 pipes.

(iv) C.I. S/S Pipes

Class	Pressure(kg/cm^2)
LA	6
A	9
B	12

Design Formula

Hazen and Williams formula is to be used for the design of the distribution system.

1.4 FINANCE

Considerable emphasis is being given to the RWSS. as laid in the 'International Drinking Water and Sanitation Programme 'to make all the villages of the countries provided with the safe drinking water by 1990. Our national Government is also taking keen interest in this field to fulfill the target. But to do this our developing country needs much financial assistance. So this assistance is being taken from International and National financing concerns. For the U.P. Jal Nigam the finance pattern has two ways - Plan and Non-plan. Under plan,the finance is given by IDA and Non-IDA procedures. In IDA procedure the finance comes 50 percent from IDA, an affiliate of the World Bank and 50 percent from the LIC (India). Under Non-IDA, the finance is provided by Central and State Governments through granting and loaning ways, according to the

financial situation of the area concerned, and by the LIC and other Banks through loaning, which is to be returned in few years by the Department. Government gives 100 percent grant to the scheme whose public finance condition is poor and there is no proper source of return of money and 75 percent grant and 25 percent loan or 50 percent grant and 50 percent loan, to the schemes whose area is prosperous. Under the non-plan deposit work comes. If Department contracts some private concern's scheme, the Department needs full cost of the scheme in advance deposited and work will be started after full payment to the Department. To accelerate the National Water Supply and Sanitation Programme (Rural), the financial assistance is to be needed urgently. For this at this time UNICEF and Dutch Government are giving finance.

1.5 NEED FOR AN OPTIMAL DESIGN

The distribution system of a water supply scheme has a major part of the cost incurred on the scheme. So, it should be designed economically. There is no proper and accurate method to design the network system in an optimal manner. But there are more works on network analysis. By this analysis we can optimize the network by changing the diameters of the pipes. Nowadays we have computer facilities available generally in our country, so that through computers we can analyse even a big network within seconds by using an efficient computer

programme. The RWSS where finance is a main problem, can benefit considerably through efficient, optimal designs. In the present study an analysis of few RWS schemes under implementation of U.P. Jal Nigam have been made by a modified and efficient computer programme to bring out the efficiency and advantages of computer use in such large investment projects.

2 PRESENT STUDY

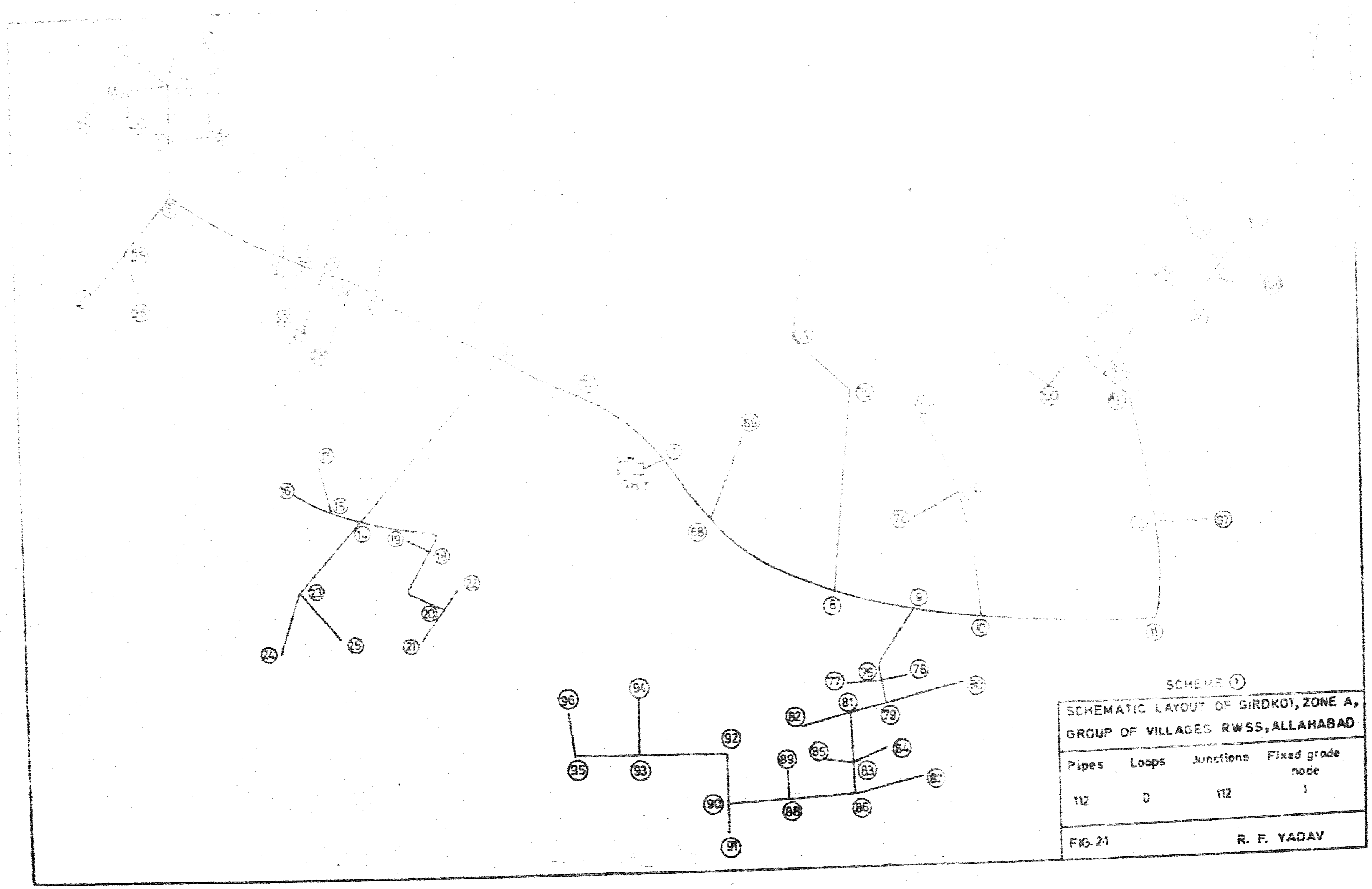
2.1 GENERAL

The topic of RWS in U.P., for which not only our State or Central Government is taking interest but some other Foreign Governments and International Organisations are giving help, has been selected for the study. The Chief Engineer (Project and Design) and one Research Executive Engineer of U.P. Jal Nigam provided the necessary background and details about the RWS schemes. Reports of three RWS schemes of District Allahabad were made available. Also the Executive Engineer, IInd T.C.D. Kanpur provided valuable informations and details of two RWS schemes of District Kanpur. The details of the various schemes are in the next sections.

2.2 SALIENT FEATURES

A. Girdkot, Zone A, Group of Villages RWSS[14].

Name of programme	:	N.W.S.P. (Rural)
Name of Local Body	:	District Board, Allahabad
Number of Villages Covered	:	16
Population	:	Present: 7,476 (1971)
		Designed: 11,214 (2001)
Rate of W/S	:	70 l.p.c.d.
Source of W/S	:	Tube well
Nature of Treatment	:	Pressure feed type chlorination



SCHEME ①

SCHEMATIC LAYOUT OF GIRDKOT, ZONE A, GROUP OF VILLAGES RWSS, ALLAHABAD

Pipes	Loops	Junctions	Fixed grade node
112	0	112	1

FIG. 2·1 R. P. YADAV

Conveyance	:	A.C. and P.V.C. pipes
Service Storage	:	One O.H.T. of Capacity : 200 KL(based on 1/4th of the ultimate daily requirement of water) Staging : 15 m Material of construction : RCC
Distribution system	:	Peack factor : 2.4 Minimum size: 25 mm(internal) Minimum terminal pressure:7 m Kind,size and class of pipe

Kind of pipe	Size,Ø(mm)	Class	C
A.C.	125 to 250	10	130.00
P.V.C.	25 to 100	4 to 10 kg/cm^2	140.00

Estimated Cost	:	9.00 lacs
Pumping plant	:	Plant capacity: 25 BHP Pumping Hours : 10
Draw off rate of balancing reservoir	:	16 Hours (standard)

This scheme comes in Handia Tehsil of Allahabad District. The area under Handia Tehsil is such that there is no river or any other natural source to get drinking water in abundant quantity. It is very difficult to get water. In summers the draught condition is a regular feature. The ground water

condition is good here, so this water is to be utilized for drinking. This rural water supply scheme has been drawn up for the villages which are draught affected and the villages which come in the alignment of pipe lines for draught striken villages.

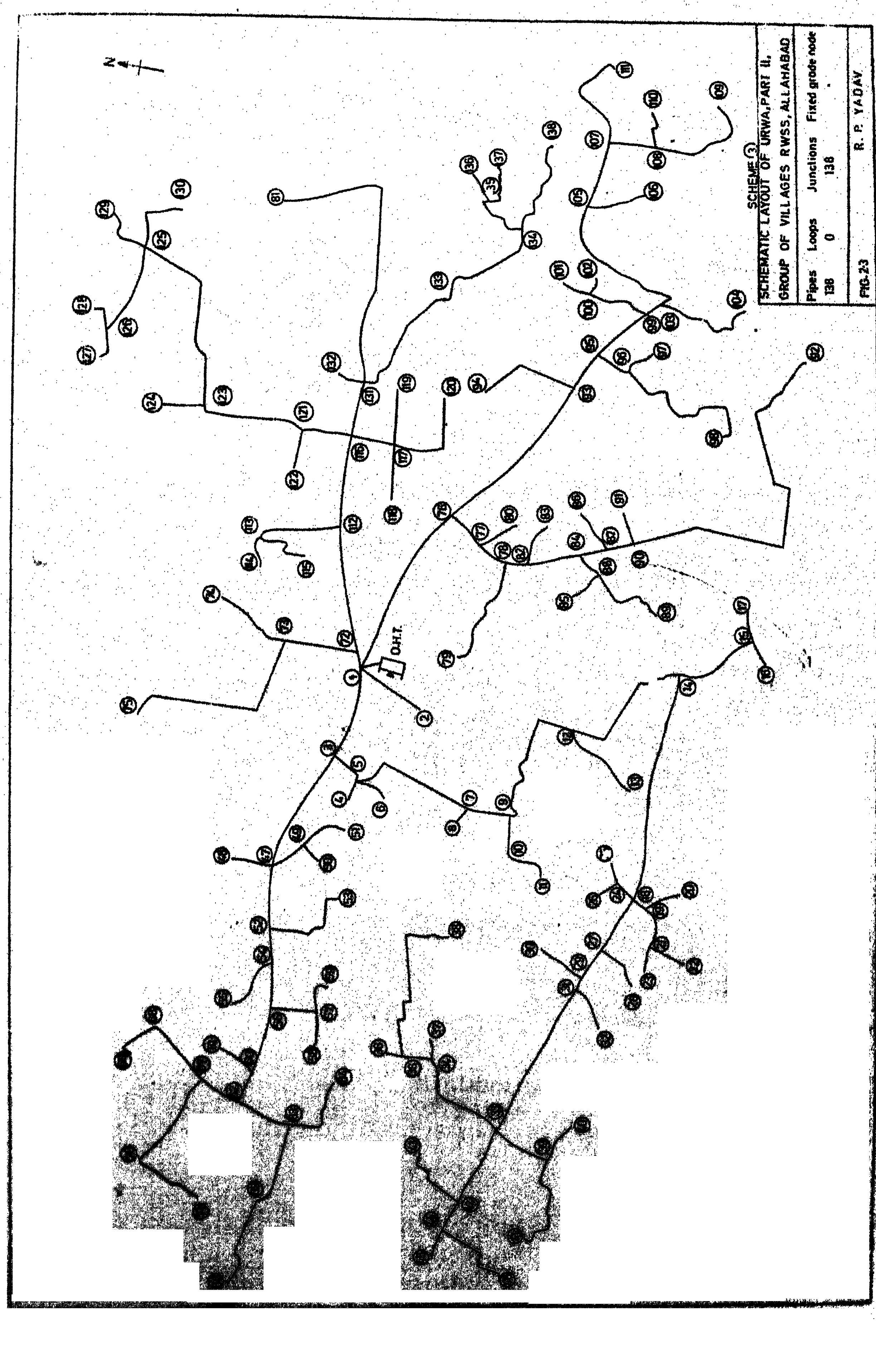
Taking the design period 30 years, the designed population at the end of the design period i.e. in the year 2001 has been taken as 11,214 assuming 50 percent increase over the 1971 population taking into account the future growth and development.

To make the scheme economical it was divided into zones as follows:

Zone	Number of villages	Population designed
A	16	11,214
B	21	11,814
C	21	14,590

B. Ketehra, Zone A, Group of Villages RWSS[15]

Name of the programme	:	NWSP (Rural)
Name of the Local body	:	District Board, Allahabad
Number of villages covered	:	13
Population	:	Present: 7,123 (1971)
		Designed: 10,693 (2001)
Rate of W/S	:	68.1 l.p.c.d.


N
O.H.T.
SCHEME (3)
SCHEMATIC LAYOUT OF URWA, PART II, GROUP OF VILLAGES RWSS, ALLAHABAD
Pipes Loops Junctions Fixed grade node
138 0 138 1
R. P. YADAV
FIG-23

Nature of source	:	Tube well
Source of Development	:	Pump House
Nature of treatment	:	Pressure feed type chlorination
Conveyance	:	A.C. and P.V.C. pipes
Service storage	:	One RCC O.H.T. of
		Capacity: 120 KL(based on 1/6th of the ultimate daily requirement of water)
		Staging : 17 m
Distribution system	:	Peak demand factor: 2.4
		Minimum terminal head: 7.0 m
		Minimum size : 25 mm
		kind, size and class of pipe

Kinds of pipes	Size,Ø(mm)	Class	C
A.C.	125 to 250	II	130.00
P.V.C.	25 to 100	-	140.00
G.I.	15 to 20	Light quality	-

Estimated cost	:	9.0 lacs
Pumping plant	:	Plant capacity: 20 BHP
		Pumping Hours: 10
Draw off rate of balancing reservoir	:	16 Hours (standard)

This scheme also comes in Handia Tehsil of District Allahabad. Due to absence of river a any other natural source the ground water is to be supplied for drinking to the draught

striken, Ketehra group of villages, the condition of which is good.

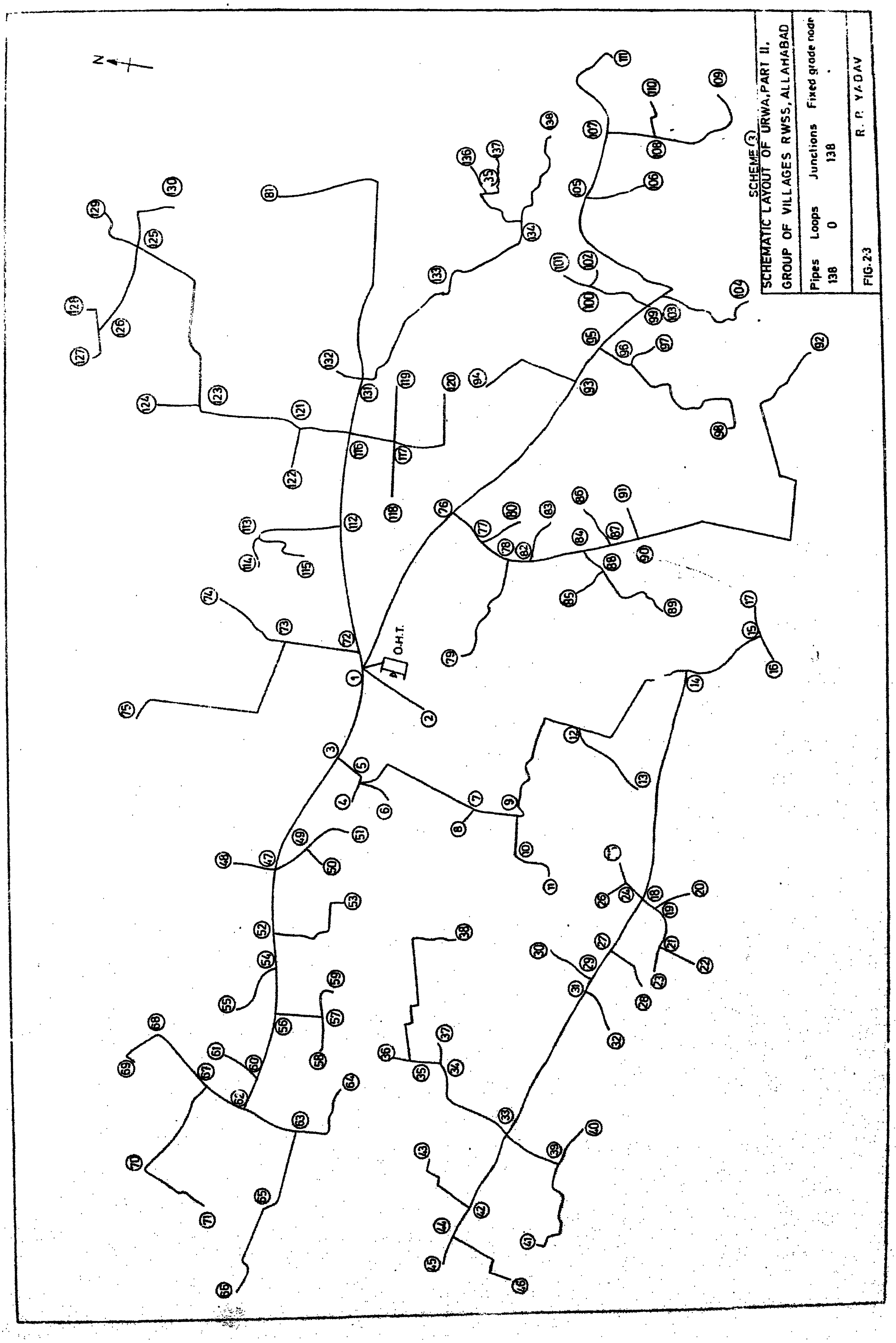
As per 1961 Census, the population of all the 52 villages covered by this scheme was 19,643. The estimate of this scheme was originally prepared by scarcity division, Mirzapur in the year 1972-73 and the population of 1971 Census was taken as the initial population by increasing the population of 1961 Census by 25 percent which comes to be 24,541. This was assumed that over a period of 30 years further increase in population would be 50 percent keeping a margin for family planning measures and migration of rural population to urban areas, including floating population due to occurance of cattle fair and religious festivals.

To make the scheme economical it was divided into three zones as follows:

Zone	Number of villages	Population designed
A	13	10,693
B	20	16,593
C	19	9,533

C. Urwa, Part II, Group of Villages RWSS[16]

Name of programme	:	Dutch programme
Name of local body	:	District Board, Allahabad
Number of villages covered	:	23


N
O.H.T.
SCHEME (3)
SCHEMATIC LAYOUT OF URWA, PART II.
GROUP OF VILLAGES RWSS, ALLAHABAD
Pipes Loops Junctions Fixed grade node
138 0 138 1
R. P. YADAV
FIG. 2.3

Population	:	Census, 1971 : 16,836 Present, 1981 : 20,246 Designed, 2011 : 30,369
Rate of W/S	:	70 l.p.c.d. for population<4,000 90 l.p.c.d. for population>4,000
Source of W/S	:	Tube well
Nature of treatment	:	Chlorination by differential pressure feed type chlorinating plant
Conveyance	:	Forced main of C.I.(class, LA, C=100.00) S/S pipe of

Ø(mm)	Length(m)
200	300
300	50

Service storage	:	One O.H.T. of R.C.C. having Capacity: 650 KL(based on 1/4th of the ultimate daily requirement of water) Staging : 14m
Distribution system	:	Peak demand factor : 2.4 Terminal head: 6m for single storied building with few house connections 8m for double storied bouilding Minimum size of pipe: 25 mm

Kind, size and class of pipes

Kind	Size, Ø(mm)	Class	C
A.C.	200 to 250	10	130.00
P.V.C.	25	10 kg/cm^2	140.00
	32 to 40	6 kg/cm^2	140.00
	50 to 150	4 kg/cm^2	140.00

Appurtenances : Sluice valve : 52 nos.

Wheel valve : 4 nos.

Air valve single ball screwed down type 20 mm : 12 nos.

Fire hydrant : 15 nos.

Single tap type Stand post : 42 nos.(30 percent for scheduled cast localities)

Average dose of chlorination : 0.5 PPM

Estimated cost : 39.23 lacs

This scheme falls under Tehsil Meja, District Allahabad. Scarcity of drinking water is a regular feature in summer in this area. To face the draught conditions in every summer of the area a permanent piped water supply has been proposed. The railway line from Allahabad to Mirzapur goes across through this village group. In the southern side of the railway line there is URWA, Part I , group of villages RWSS which has already been implemented. In the north side of the same this scheme

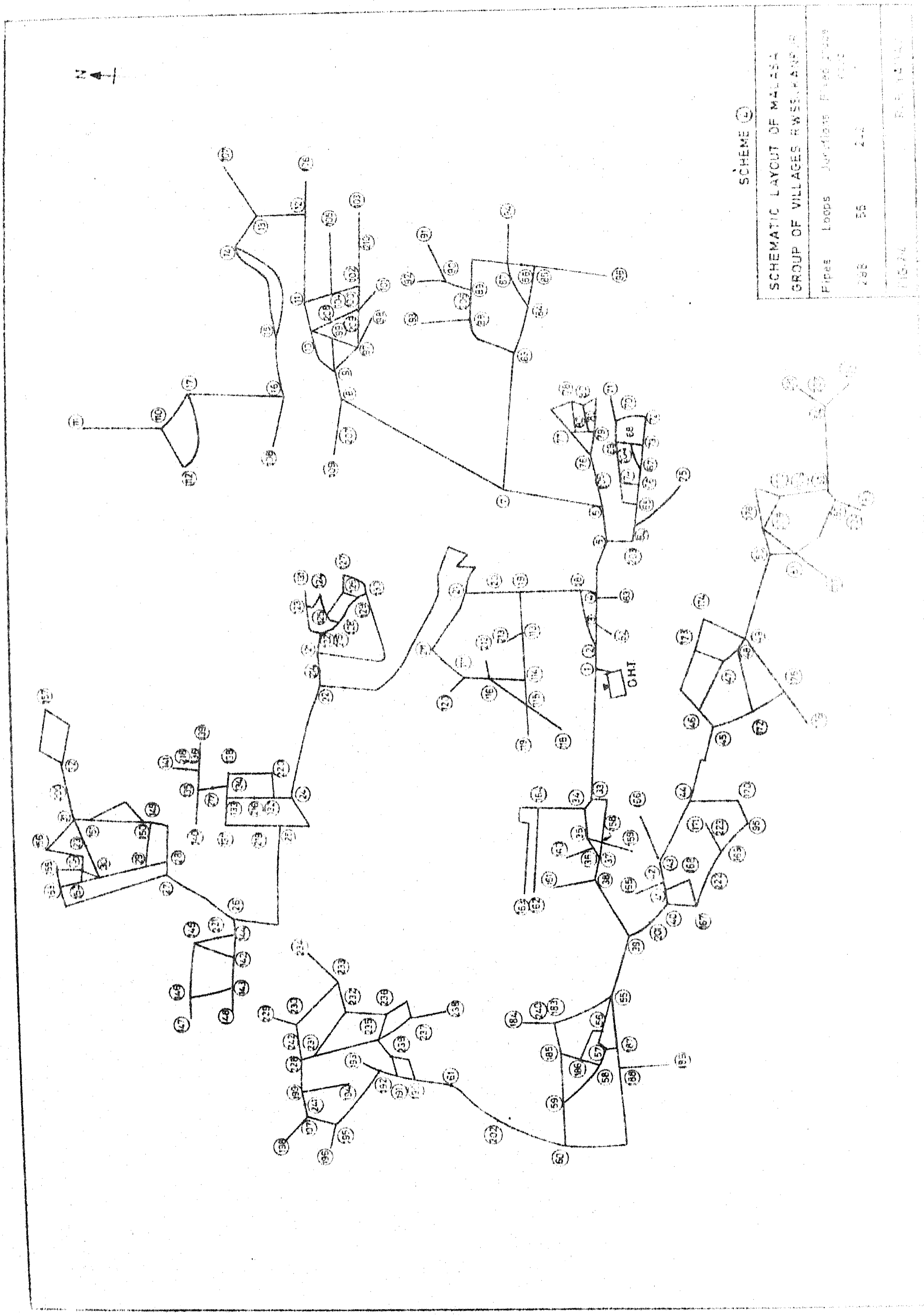
is to be implemented.

The base year for the design period is 1981. As per Census figures the growth of population in the district is 20.4 percent for 1961 to 1971 decade; so to arrive at the population for 1981, the 1971 population has been increased by 20.4 percent. The ultimate population has been calculated for the year 2011 anticipating an increase of 50 percent. Over the 1981 population.

Two centrally located tube wells with pumping plants designed for discharge of 2000 lpm, at a head of 40 meters with 25 HP motor running 6.5 hours each in the beginning, 8 hours in the middle and 9.5 hours at the end of the design period shall be sufficient to cope with the need of scheme.

D. Malasa Group of Villages RWSS[17]

Name of the programme	: NWSP (Rural)
Name of the local body	: District Board, Kanpur
Number of villages covered	: 15
Population	: Present : 15,400 (1978)
	Designed: 23,100 (2008)
Rate of W/S	: 70 l.p.c.d.
Nature of source	: Tube well
Source of Development	: Pump house
Nature of Treatment	: Gaseous injector type chlorination using chlorine gas


SCHEME
SCHEMATIC LAYOUT OF MALASA
GROUP OF VILLAGES RWSS
Pipes
Loops
Junctions
288
55
244
O.H.T
N

Conveyance	:	Forced main working on maximum pressure of 60 m water head of C.I. (class LA) having 200 mm internal dia and 330 m length.
Service storage	:	One O.H.T. of RCC of
		Capacity : 500 KL(based a 1/4th of the ultimate daily requirement of water)
		Staging : 20 m
Appurtenances	:	Sluice valves : 40 nos.
		Wheel valves : 35 nos.
		Air valves : 5 nos.
		Scour valves : 5 nos
		Public stand posts proposed single tap pillar type : 75 nos.(18 nos. are for weaker section).
Distribution system	:	Peak demand factor : 2.4
		Terminal' pressure : Min. 6m head
		Minimum size of pipe : 25 mm
		Kind, size and class of pipes

Kind	Size,Ø(mm)	Class	C
A.C.	125 to 250	II	130.00
P.V.C.	25 to 100	-	140.00

Dose of chlorination	:	Maximum : 2.0 PPM
		Average : 0.5 PPM
		Range : 0.1 to 2.0 PPM
Estimated capital cost	:	25.48 laccs

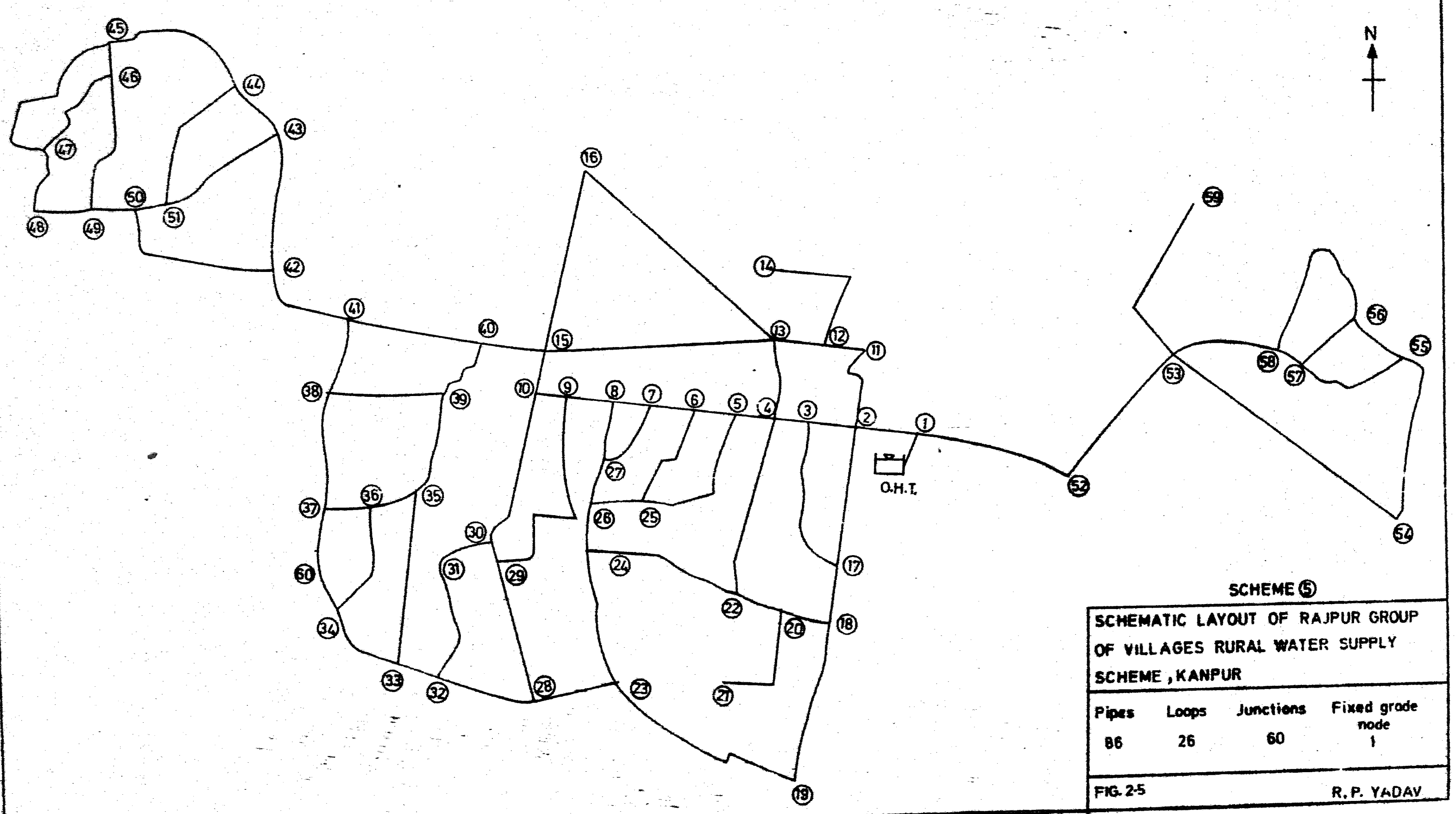
Pumping plant	:	Two electrically driven oil lubricated vertical base hole turbine pumping plants
		Plant capacity : 35 BHP
		Pumping Hours : 16
Draw off rate of balancing reservoir	:	16 hrs (standard)
Number of tubewells	:	2 (one standbye)

The villages draw their daily requirement of water for drinking and domestic purposes from open wells and hand pumps which are inadequate in number and are liable to contamination. The available water of the wells in some of the villages is brackish as well as unhygienic which is not advisable for human use. Besides this the ground water level in this area is considerably low varying from 19 to 25 meters below ground level. So, piped water supply becomes essential in this area.

The 1971 Census population of the proposed group of villages is 13,883. The population in the beginning of the design period (1978) works out to be 15,400 by increasing the 1971 Census population by 12 percent. The design population after a period of 30 years (2008) works out to be 23,100 after increasing the initial population by 50 percent.

E. Rajpur Group of Villages RWSS[18]

Name of the programme	:	NWSP (Rural)
Name of local body	:	District Board, Kanpur



SCHEME 5

SCHEMATIC LAYOUT OF RAJPUR GROUP OF VILLAGES RURAL WATER SUPPLY SCHEME, KANPUR

Pipes	Loops	Junctions	Fixed grade node
86	26	60	1

FIG. 2-5 R. P. YADAV

Number of villages covered	3
Population	Present: 6,439 (1976) Designed: 10,000 (2006)
Rate of W/S	70 l.p.c.d. for population <4,000 90 l.p.c.d. for population >4,000
Nature of source	Tube well
Source of Development	Pump house
Nature of treatment	Pressure feed type chlorination
Conveyance	Forced main of C.I. (class LA) having

size Ø(mm)	length(m)
125	400
150	30

Service storage	One RCC O.H.T. of Capacity: 135 KL (based on 1/6th of the ultimate daily requirement of water) Staging : 12 m
Distribution system	Peak demand factor : 2.4 Minimum terminal pressure: 6 m Minimum size: 32 mm

Kind	size Ø(mm)	Class	C
A.C.	65 to 200	II	130.00
P.V.C.	32 to 50	-	140.00

Appurtenances	Sluice valve : 15 nos. Air valve : 2 nos. Fire hydrant : 4 nos.

Standposts	: Single tap piller type : 10 nos.
Dose of chlorination	: Maximum : 2 PPM
	Average : 0.5 PPM
Estimated capital cost	: 7.05 lacs
Number of tube wells	: Two (one standbye)
Pumping plant	: Plant capacity : 7.5 BHP
	Pumping Hours: 14
Draw off rate of balancing reservoir	: 16 hrs. (standard)

The open wells are only the sources of drinking water in this area, which are liable to be contaminated and in summer draw inadequate water. Water table of the area is nearabout 20 m deep. So,piped water supply has been necessitated.

As per 1971 Census, the population of proposed group of villages is 5,699. The initial population (1976) works out to be 8,439 after allowing increase of 2.7 percent per year. Population after 30 years (2006) works out to be 10,000 after increasing the initial population by 50 percent.

2.3 COSTS FOR EFFICIENT DESIGN

The water supply distribution networks of the five schemes were analysed at the I.I.T. Kanpur computer facility by an efficient computer programme. After analysis it was found that the some schemes were overdesigned i.e. Ketehra and Rajpur.

The pressure heads at the terminal point are much more than that specified in design criteria. Some schemes were deficient and the pressure heads at the terminal points are much less than the specified, i.e. Girdkot, Urwa and Malasa. So, keeping in mind the minimum requirement of the pressure heads at the terminal points, the diameters of some pipes were changed according to the condition, to get more pressure head the diameter was increased, and final costs of the schemes were calculated. Table 2.1 shows the details of costs and savings.

TABLE 2.1: COST AND SAVING DETAILS OF THE SCHEMES

Schemes	Initial Cost (Rs.)*	Final Cost (Rs.)*	Saving (Percent)
A	3.42	3.44	-0.58
B	3.12	3.11	+0.32
C	15.00	15.26	-1.73
D	9.13	9.39	-2.85
E	1.78	1.57	+11.80

* In lacs

2.4 COMPARATIVE STUDY

TABLE 2.2 : COMPREHENSIVE ABSTRACT OF COST

Items	Schemes				
	A.1**	B.1***	C	D	E
1	2	3	4	5	6
Distribution system	14,47,600	15,12,000	19,30,111	11,80,000	2,25,000
Over head tank	3,70,000	2,96,000	3,20,000	2,32,000	80,000
Pumping plants	1,79,000	1,78,862*	1,34,000	1,40,000	40,000
Pump House and chlorinating room	33,000	29,000	22,000	14,000	10,000
Staff building	1,31,600	1,68,000+	87,000	22,500	-
Rising main	14,600	14,000	58,000	48,000	22,800
Boundary wall, approach road and gate	47,200	-	20,000	7,500	1,08,000
Electric transmission line	48,100	55,300	2,42,500	90,000	20,000
Chlorinating plant	9,000	-	6,000	14,000	4,000
Tubular shed	20,000	20,000	3,600	5,400	2,400
Purchase of special T and P	71,000	71,000	29,000	15,000	-

Table contd.....

Table 2.2 contd...

1	2	3	4	5	6
Extra cartage of material	5,000	-	-	8,500	4,000
Land acquisition	-	5,000	7,500	-	-
Water meters	-	-	33,060	29,600	10,000
Internal electrification	-	-	-	4,000	-
Provision of work required for diverting the surplus water- for agricultural use		-	-	5,900	-
	23,76,100	23,49,162	28,92,771	18,16,400	5,26,200
Total (Rs. in lacs rounded off)	23.76	23.49	28.93	18.16	5.26

* Cost includes for pumping plants plus chlorinating plant

\+ Cost includes for staff building plus boundary wall, approach road and gate

** Girdkot group of villages RWSS , Allahabad

*** Ketehra group of villages RWSS, Allahabad

TABLE 2.3 : COSTS OF OVER HEAD TANKS

Sl. No.	Schemes	Sta-ging (m)	Capa-city (KL)	Cost (Rs.)	Year	Cost esti-mated in 1980(Rs. in lacs)
1.	A	15	200	1,23,333	1978	1.36
2.	B	17	120	86,500	1978	0.95
3.	C	14	500	3,20,000	1979	3.36
4.	D	20	500	2,32,000	1976	2.82
5.	E	12	135	80,000	1975	1.02

Average cost per 100 KL = Rs. 0.654 lacs

TABLE 2.4: ECONOMICS

Items	Schemes					Average
	A.1*	B.1**	C	D	E	
	1971 (2001) -	1971 (2001) -	1981 (1996) (2011)x	1978 (2001) (2008) x	1976 (2006) -	2001
Total population	25,069 (37,618) -	24,541 (36,819) -	20,246 (25,307) (30,369)x	15,400 (21,520) (23,100)x	6,439 (10,000) -	
Total capital cost (Rs.)***	30.00 (30.00) -	29.95 (29.95) -	29.23 (29.23) (29.23)x	25.48 (25.48) (25.48)x	7.05 (7.05) -	
Total annual maintenance cost (Rs.)	86,000 (1,33,800) -	78,000 (1,13,000) -	86,000 (1,07,900) (1,29,800)x	1,45,000 (1,60,000) (1,11,820)x	35,700 (27,200) -	
Cost of scheme per capita(Rs.)	119.66 (79.75) -	122.03 (81.34) -	194.00 (155.01) (129.00)x	165.45 (118.40) 110.00	110.00 (71.00) -	101.10
Maintenance cost per capita(Rs.)	3.43 (3.56) -	3.18 (3.07) -	4.25 (4.26) (4.27)x	9.45 (7.43) (4.84)x	5.54 (2.72) -	4.21
Water cost per KL (Rs.)	0.13 (0.14) -	0.13 (0.13) -	0.21 (0.21) (0.21)x	0.37 (0.29) (0.19)x	0.22 (0.11) -	0.18

* Girdkot group of villages RWSS, Allahabad Total cost of scheme/1000 of pupulation(2001)=Rs.1.05***

** Ketehra group of villages RWSS, Allahabad

*** In lacs

2.5 TYPICAL FEATURES OF A RWSS

According to the comparative study of the economics of the five U.P. Rural Water Supply schemes we get an average total of expenditure incurred on scheme on per capita basis. Per capita average total of expenditure on scheme will be equal to the sum of average per capita capital cost of the scheme and average per capita maintenance cost. The total for the year 2001 comes as Rs. 105.31. This per capita cost of the scheme is helpful for one to know the cost of the scheme, when population is known. One can easily get a total cost of the RWWS in a particular year, when the population to be served is known for that year, allowing a provision of appropriate annual compound interest (say 5 percent).

By the comparative study of over head tanks for all RWS schemes, the costs of the over head tanks for the year 1980 have been calculated by giving a provision of 5 percent annual compound interest. We have got an average total expenditure on over head tank on 100 KL basis, as Rs. 65,400.00. So, we can easily estimate the expenditure incurred on over head tank in an particular year of construction, if we know the capacity of over head tank.

It has been found from the present study that the Over Head Tank for each RWSS was designed and constructed seperately. It incurres extra expenditure for its design for each scheme . It also creates difficulty in construction due to changes in each O.H.T.'s , so the working efficiency for the staff for construction becomes low giving more expenditure on scheme. Therefore, it is a need for standardization of O.H.T.'s. There can be a few O.H.T.'s . When we will go to design the distribution system, we can choose a standard design of O.H.T. of standard capacity to suit the scheme.

From the analysis of the network system of the schemes, it has been found that the required terminal pressure heads at some terminal points were not satisfied. There is no accurate method of the analysis in the Department. Manual analysis is very difficult. So, there is a need of distribution analysis by computer. With this we can modify the distribution system to get a nearly optimized network.

Also there is a need of standard features for staff buildings, approach roads and stores etc.

3 ANALYSIS OF WATER DISTRIBUTION SYSTEM

3.1 GENERAL

A few RWS schemes have been taken from U.P. Jal Nigam to get their water distribution networks analysed as discussed in previous chapter. These schemes are traditionally designed and there is no suitable and accurate method in the Department to analyse the schemes. While urban water supply schemes receive considerable attention, in terms of efficient analysis and design, there appears to be no such attempts towards optimal design in RWSS, eventhough the cost involved is in no way a small amount. So, it is essential to analyse the rural water supply distribution network to meet the flow and pressure requirements and to make the scheme optimal as for as feasible.

3.2 NETWORK ANALYSIS PROGRAMME

An efficient computer programme for the analysis of pressure and flow in pipe distribution systems, prepared by University of Kentucky, was available with Dr. K. Subramanya. This programme was suitably modified and implemented on the IIT Kanpur computer system, DEC 1090. This programme gives rapid and accurate results in only few trials. Features of this programme are given in Appendix I. The computer programme is written in FORTRAN IV, G level. It consists of a main

programme and five sparse matrix subroutines to solve the p linearized simultaneous equations where p is the number of pipes in the system. Before going to the programme a few terms related to distribution network are being defined.

(i) Node

The end points of pipes are called nodes.

(ii) Junction Node

It is a node where two or more pipes meet or where flow is put in or removed from the system. If a pipe diameter changes occurs at a component such as a valve or a pump, this point is a junction node.

(iii) Fixed Grade Node

It is node in the system where both the pressure and elevation (or hydraulic grade line i.e. piezometric head) are known. This is usually the surface of a storage tank or reservoir or a source or discharge point of specified pressure. Each system must have at least one fixed grade node.

(iv) Primary Loop

It is a closed pipe circuit with no closed pipe circuits contained within it.

If the junction, primary loops, and fixed grade nodes are identified as described here the following holds for all pipe system:

$$p = j + l + t - 1 \qquad (3.1)$$

where, p = number of pipes

j = number of junction

l = number of primary loops

and t = number of fixed grade nodes.

(v) Pipe System Components

<u>Pipes:</u>

The length, inside diameter and roughness of each pipe must be input as data. One can use roughness coefficient both for Hazen Williams equation and Darcy-Weisbach equation.

<u>Pumps:</u>

A pump can be included in any line of the pipe system. The characteristics of the pump can be input in two **ways** :

i) The power the pump puts into the system (in Horse power or killowatts)

ii) Minimum three points of operating data (Head-discharge) under normal operating range. This program is designed to work also if the points are outside the normal operating range. A second order curve can be fit to this data to obtain a pump characteristic curve describing the pump operation of the forms

$$E_p = A + BQ + CQ^2 \qquad (3.2)$$

where A, B, C, are the characteristic coefficients and E_p is the head corresponding to the discharge Q.

Minor Loss:

A number of components in a pipe system (such as valves, junctions, bends, meters etc.) produce a head loss, calling minor loss. It could be input easily

$$H_{LM} = M \frac{V^2}{2g} \qquad (3.3)$$

where M = minor loss coefficient

V = line velocity

and g = acceleration due to gravity.

Check Valve:

These valves allow flow only in the specified direction. If flow reversal occurs the valve shuts and the line causes no flow.

Pressure Regulating Valves (PRV's):

These valves are designed to maintain a specified discharge pressure (PR) which is lower than the pressure upstream from PRV.

3.3 FORMULATION FOR THE ANALYSIS

3.3.1 Basic Equations

Equation (3.1) giving the relationship between the

number of pipes, loops, junctions, and fixed grade nodes becomes significant when formulating a proper set of hydraulics equations to describe a pipe system.

In terms of the unknown discharge in each pipe, a number of continuity and energy equations can be written equating the number of pipes in the system.

i) Continuity Equation:

For each junction node the flow into the junction should be equal to the flow out of the junction, written as follows:

$$Q_{in} = Q_{out} \quad \text{(j equations)} \tag{3.4}$$

ii) Energy Equations:

For each loop the sum of head loss around a loop should be equal to the sum of the energy put into the loop liquid by a pump. So for each loop the energy equation can be written as follows:

$$\Sigma h_L = \Sigma E_p \quad \text{(l equations)} \tag{3.5}$$

where h_L = head loss in each pipe (including minor loss)

E_p = energy put into the liquid by a pump.

If there are no pumps in the loop then the energy equation will state that the sum of the head loss around a loop equals zero.

If there are t fixed grade nodes, t-1 energy equations can be written for paths between any two fixed grade nodes as follows:

$$E = \Sigma h_L - \Sigma E_p \quad \text{(t-1 equation)} \qquad (3.6)$$

where E = grade difference between the two fixed grade nodes.

Any path in the pipe system can be chosen between these nodes. However, care must be taken to avoid redundant paths. The best method to avoid this difficulty is to either choose all paths starting at one source (like A-B, A-C, A-D, etc.) or to use the previous end point for a path as the starting point for the next path (like A-B , B-C, C-D, etc.). Either of these methods will result in t-1 equations with no redundant ones. These junction equations (continuity equations) and loop and path equations (energy equations) constitute a set of simultaneous nonlinear equations which can be solved for the discharge in each line.

3.3.2 Direct Solution of Linearized Equations

Because of the nonlinear nature of the above equations a direct solution is not possible. A linearization procedure is used to handle the non-linear head loss and pump terms so the system of equations can be cast as a set of p linear simultaneous equations which can be solved by routine matrix methods. Essentially the technique used to solve the system equations is this.

Based on an assumed flow in each line (a velocity of 4 units in each pipe is used) the non-linear hydraulic equations are linearized and the linearized equations are simultaneously solved for the flowrates. This set of flowrates is used to linearize the equations and a second solution is obtained. The procedure is repeated until the change in flowrates obtained in successive trials is insignificant. Because all flows are computed simultaneously, convergence is assured and occurs very fast compared to other procedures. Usually only 4-6 trials are required even for large systems. In the present study for the large system, 2 trials were required in tree type configuration and 6 trials in looped type configuration.

3.4 COMPUTER FLOW DIAGRAM

The simplified computer flow diagram has been given on page 49 .

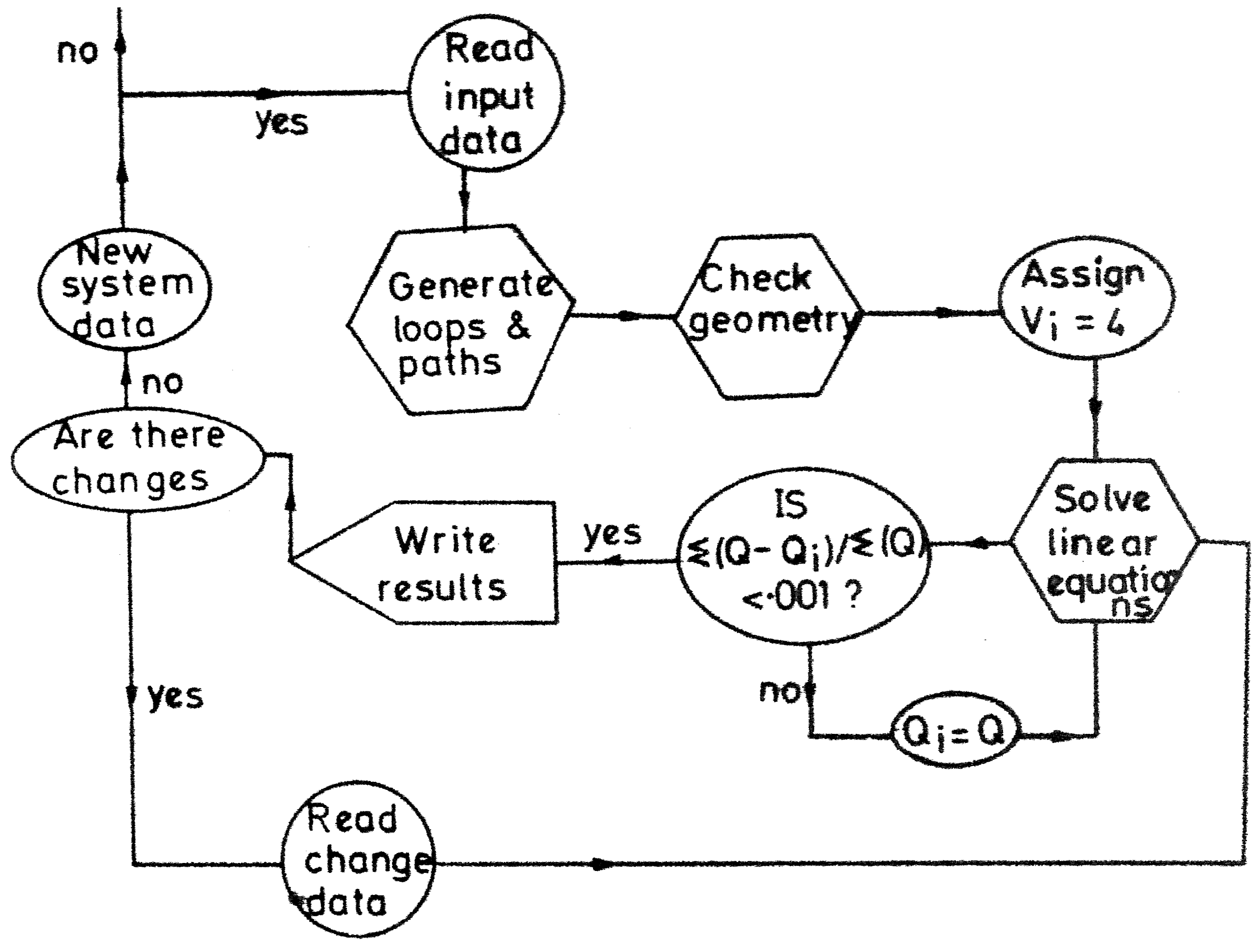


FIG. 3·1 SIMPLIFIED COMPUTER FLOW DIAGRAM

3.5 BASIC EQUATIONS

The line head loss is given by

$$h_{LP} = K_P \, Q^n \tag{3.7}$$

where K_P = pipe line constant

Q = discharge in the pipe line

and n = exponent

For Hazen Williams equation

$$K_P = \frac{K_1 \, L}{C^{1.852} \, D^{4.87}} \tag{3.8}$$

and $n = 1.852$

where L = pipe line length

C = Hazen Williams Roughness coefficient

D = internal pipe diameter

and K_1 - is a coefficient

= 10.69 for SI units

= 4.73 for English units

For Darcy Weisbach Equation

$$K_P = \frac{K_2 \, fL}{D^5} \tag{3.9}$$

and $n = 2.0$

where f = friction factor

L = pipe line length

D = internal pipe diameter

and K_2 is a coefficient

= 0.08265 for SI units

= 0.02517 for English units

Minor losses are given by a loss coefficient, M, which multiplies the velocity head to give the loss at the component. This is

$$h_{LM} = M \frac{V^2}{2g} \qquad (3.10)$$

where V = the mean line velocity

and g = the gravitational constant

In terms of the discharge this is

$$h_{LM} = K_M Q^2 \qquad (3.11)$$

where $$K_M = \frac{K_3 M}{D^4} \qquad (3.12)$$

Q = discharge in pipe line

D = internal dia of the pipe line

and K_3 is a coefficient

= 0.08265 for SI units

= 0.02517 for Engligh units

The effect of minor loss will be insignificant on the nodal pressure heads so it has not been considered in the present study.

The pump head is expressed in two ways:

i) When pump power is given , general equation for pump head is

$$E_P = \frac{P}{\gamma Q} \tag{3.13}$$

where P = power of the pump in watts

γ = specific weight of the liquid = $\gamma_w S$

Q = discharge in the pipe line

γ_w = specific weight of the water

and S = specific gravity of the liquid

$$\text{So, } E_P = \frac{P}{\gamma_w SQ}$$

Here, for SI units

$$E_P = \frac{1000\ P}{9806\ S\ Q}$$

$$\text{or} \quad E_P = \frac{0.10197\ P}{SQ} \tag{3.14}$$

and for English units

$$E_P = \frac{550\ P}{62.42\ SQ}$$

$$\text{or} \quad E_P = \frac{8.814\ P}{S\ Q} \tag{3.15}$$

ii) When operating points for the pump are given, the pump head is

$$E_P = A + BQ + CQ^2 \tag{3.16}$$

where A , B, and C are the coefficients of a parabolic characteristic curve which defines the pump operation in the vicinity of the operating point.

Since this expression is only valid over a specified range it should not be indiscretely employed in an analysis.

The basic energy equation for a loop or a path between fixed grade nodes is

$$(h_{LP} + h_{LM}) = E + \Sigma E_P \qquad (3.17)$$

where E is the energy difference between the fixed grade nodes.

This equation can be linearized with the continuity equations to get a set of p simultaneous linear equations in terms of the flowrates in each pipe using a gradient approximation.

3.6 IMPLEMENTATION OF THE PROGRAMME

This original programme is fairly lengthy involving 1,117 FORTRAN cards. The programme was created on the disk of the DEC 1090 system through the cards, and editing was done through the terminals (tty). After compressing the programme file, it occupies 62 blocks storage on disk. The syntax errors were corrected through the terminals. Considerable amount of time was spent on implementing the programme on the DEC system.

3.6.1 Modification due to Computer System

A large number of changes in the programme had to be made to implement it on the DEC system. The major changes are:

i) '*2' was removed from the programme and 'REAL*8' and 'REAL' were substituted by 'DATA'.

ii) In READ and WRITE statements device unit numbers were removed and only format statement number were given, also the 'WRITE' was changed to 'PRINT'.

iii) The cards were arranged in the following order:

(a) Name of subroutine;

(b) Dimension cards;

(c) Variable declaration cards, REAL and INTEGER;

(d) Common cards;

(e) DATA statement cards;

(f) Programme card.

3.6.2 Additions

Some additions were made to run the programme and to get the desired results for the present study. These are:

i) Array 'ROWCOL(2)' and 'NAME(5)' were introduced in the dimension statements in the subroutines 'MA18A' and 'MA18B' respectively.

ii) Subroutine COSTT

This subroutine was added to get the total cost of the distribution network. We can give the rate/m length of the pipe for 20 standard pipe diameters. The cost was calculated nicely to know the cost of the scheme just after each analysis.

By making some changes in the system we will get next new cost of the scheme each time. This was felt to know the cost of the scheme when an round off optimized network was being obtained by the provision of putting changes in the system.

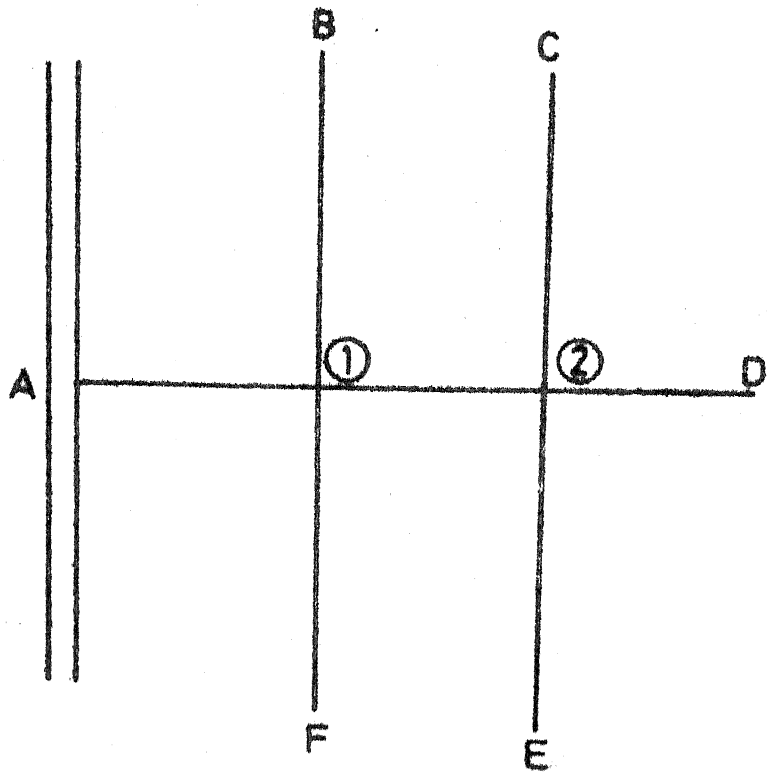
iii) Some FORMAT and PRINT statements were introduced to get the cost output and 'nice prints out' for the U.P. RWS schemes.

3.6.3 Computation Time for a Big Scheme

All the five RWS schemes were analysed on DEC 1090 system. The Malasa Group of villages RWSS is biggest one. The distribution network of this scheme is of loop type. It has 298 pipes. It has been observed that the analysis of loop type network of the same number of pipes takes more CPU time than tree type network, as previous type network takes more number of trials to get the desired accuracy limit. The distribution network of Malasa, RWSS took 7.41 seconds CPU time for its analysis. The initial analysis took 5 trials to get the accuracy of 0.00363 l/s. The analysis after changes takes only 2 trials to get the accuracy of 0.00297 l/s. The execution for this scheme uses CORES of 100P.

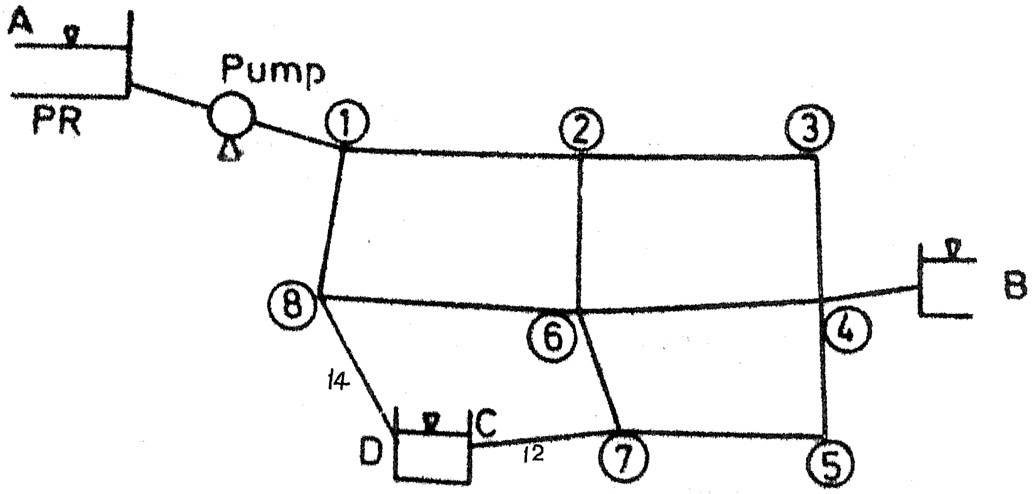
3.7 TESTS

The programme was tested for four different types of water distribution networks. The details of the problems



Fixed grades at
A = 253·62
B = 107·87
C = 80·90
D = 121·81
E = 43·98
F = 100·00

Fig. 3·2 Schematic diagram of tree type distribution system fed by a large pressure main – English Units, p = 7, l = 0, j = 2, and t = 6



Fixed grades at

A = 30·05
B = 30·48
C = 33·53
D = 33·53

Pump characteristics

E in (m)	Q (l/s)
165·61	200·00
131·85	600·00
17·83	1000·00

Fig. 3·3 Schematic diagram of loop type fourteen pipe distribution system – SI Units, p = 14, l = 3, j = 8 and t = 4

tested with computer results are as follows:

3.7.1 Test Problem No.1

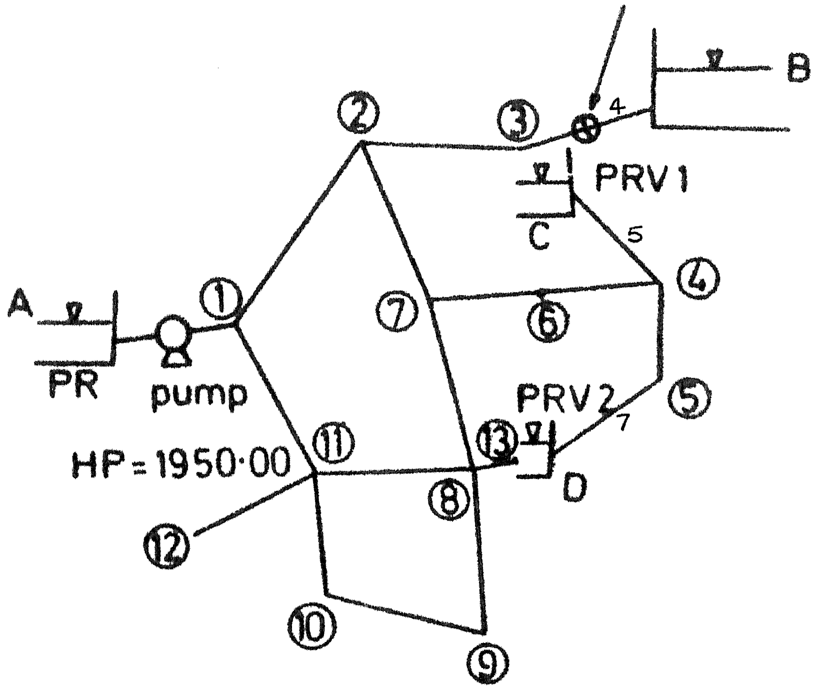
This seven pipe tree type system (Fig. 3.2) is fed by a pressurized main at a constant pressure of 60 psig. All discharge points are fixed grade nodes, labeled A-F. The liquid used is gasoline having specific gravity of 0.68. Here the Darcy Weishbach equation was used in analysis. DEC 10 has taken only 3 trials against 12 trials (previously tested problem) and gave better accuracy limit.

3.7.2 Test Problem No.2

This fourteen pipe system has 3 loops and 4 fixed grade nodes, labeled A, B, C and D (Fig. 3.3). Pipe numbered 12 and 14 both are connected to the same storage reservoir. There is a pump in line 1 and has been described by operating data. Here an option for multiplying factor to the changes for demands is used. The pump operates within the allowable range. It has taken only 3 trials against 4 trials (previously tested problem).

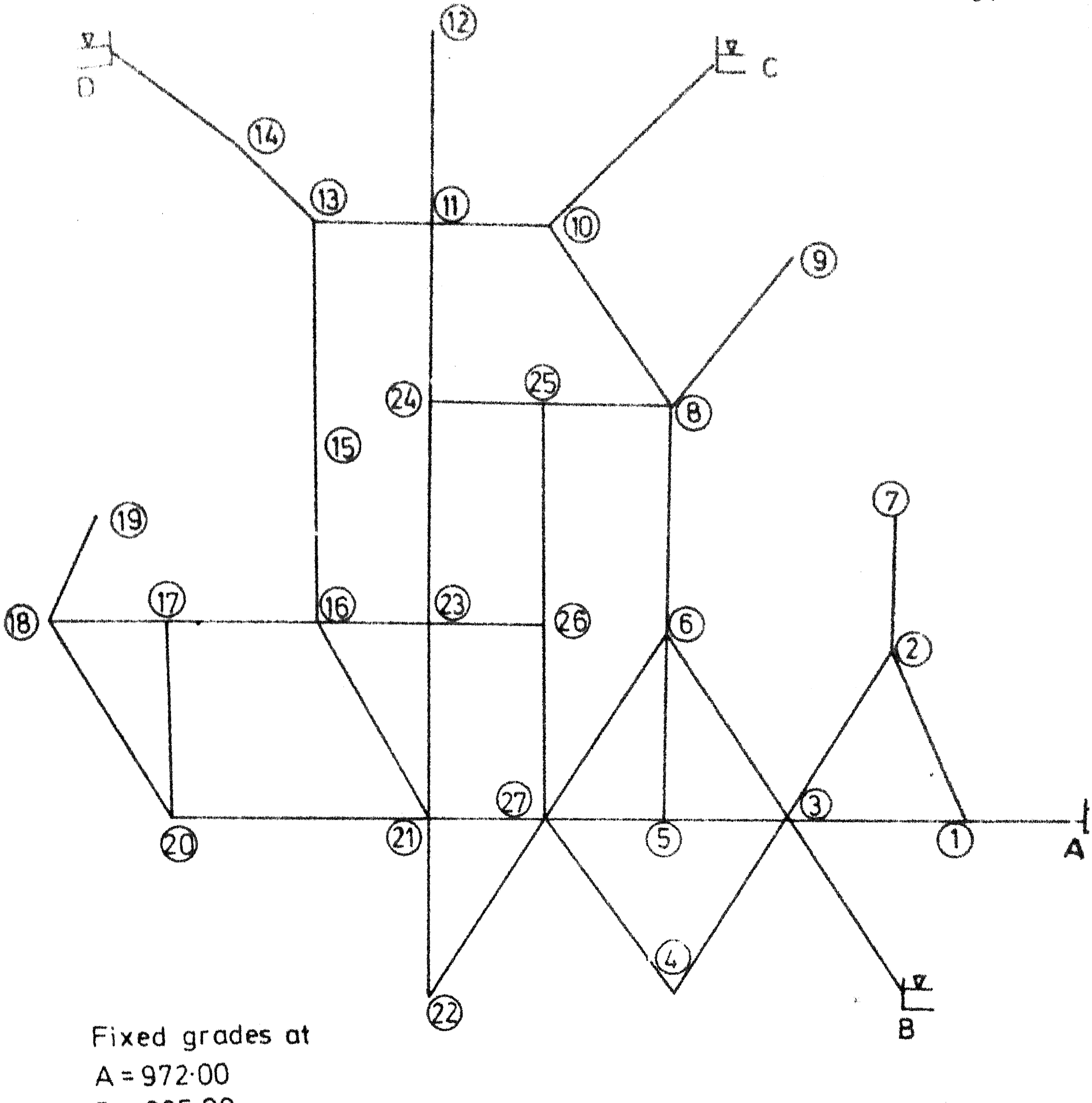
3.7.3 Test Problem No.3

The system has a pump described by the useful horse-power. An item of note is a check valve in line 4, which allows flow only in the direction towards the storage



Fixed grades at
A = 50·00
B = 200·00
C = 303·46
D = 278·46

Fig. 3.4 Schematic diagram of pipe water distribution system having one check valve, one pump and 2 PRV's - English Units, p=18, l=2, j=13, t=4



Fixed grades at
A = 972·00
B = 935·00
C = 935·00
D = 935·00

Fig. 3·5 Schematic layout of improved water distribution system for the city of montpelier, V T.- English Units, p = 43, l = 13, j = 27 and t = 4

is 7 m and 11 nodes give less pressure heads. By making changes as shown in the computer print out the scheme has been made safe giving insignificant increase in the cost of the scheme. It took only 2.87 seconds CPU time for this analysis.

3.8.2 Scheme 2

This scheme was found to be over-designed. The terminal pressure were coming more than specified, 7m. It took 1.00 second CPU time. A little cost was reduced after changes to make the network nearly optimal.

3.8.3 Scheme 3

The analysis of this scheme gave more negative pressure at some nodes . One complete branch of the network was under-designed. This 138 pipes tree type network has taken2.59 seconds CPU time for its analysis. The cost of the scheme has been increased by 1.73 percent to be safe.

3.8.4 Scheme 4

It is the biggest scheme. It comprises 298 pipes and 56 loops. It took 7.73 seconds CPU time. It was more under-designed and closely optimized scheme needed the scheme cost increased by 2.85 percent. Due to loop type it has taken 5 trials for initial analysis.

3.8.5 Scheme 5

It was too much over-designed and after making changes to get nearly optimal network, the saving turned out to be 11.80 percent. It took 2.76 seconds CPU time for analysis.

4 DESIGN OF TREE TYPE DISTRIBUTION SYSTEM

4.1 GENERAL

The essential part of all water supply schemes is the water distribution system. It comprises a considerable part of the total expenditure incurred on water supply schemes. It is apparent from the comparative study of a few U.P. rural water supply schemes, randomly selected, that 65 percent or more of the total cost of the scheme goes to the distribution system. So, optimization of the distribution network is highly desirable.

4.2 PROBLEM

The distribution systems are of mainly two types: (i) loop type and (ii) tree type. As alternate routes are available for transporting water to the demand nodes in looped systems, they are more reliable, though somewhat costlier, than the other type. Reliability is preferred to economy and also the street pattern is grid like for large communities and therefore, loop type networks are employed for urban water supply schemes. For rural water supply schemes, however cost rather than reliability is the design criterion, and also the pattern of villages is of zig-zag nature, so,tree type system is used for them.

Previously all water supply schemes were concerned with Urban communities only. But nowadays worldwide agitation is being made to provide safe drinking water to all rural communities by 1990. In view of vast financial outlay in these projects we have to select optimized distribution network in all schemes.

We can have two ways of optimizing the network systems by (i) global optimal design and (ii) **nearly** optimized design. Optimal design is really a hard task and can be only possible by an efficient computer programme using the theory of Linear Programming. The other type of design which is to be nearly optimum. This is specifically studied here.

4.3 PAST WORKS

A review of past work in this field is made here before going to the design problem for tree type network systems. Bhave[2] used the method of critical path approach for the design of dead-end system. He showed that an optimal solution could be obtained directly without trial and error by system reduction procedure and by adopting an economic friction slope. The friction slope is assumed. So, one can not be certain that the optimal solution is achieved, though it may not be far from it. Deb[9] presented a

method to get optimal solution of the branched pipe network system. He assumed a boundary condition that the total head-loss of the system through any branch is same. Khanna and Swamee[11] suggested an optimal design problem which reaches to a non-linear constraints involving an unknown procedure for solution and the work is based on simplifying the problem through approximations. Bhave[1] has a non-computer approach having steady flows. The approach is based on the critical path method, the method is simple, straight forward and gives a fairly economical distribution method without any trial and error procedure. Deb[8] suggested that for optimal design of the water distribution system , the initial costs of the pipes, pumps and elevated service reservoir, and maintenance and electricity costs should be considered. According to him the total cost of a water distribution system is dependant on the inlet hydraulic gradient and the pressure surface geometry. With the increase of inlet hydraulic head and the pressure surface parameter (the ratio of the actual slope of the pressure profile at the farthest point from the inflow to the straight line variation slope) value, the total cost decreases initially, reaches a minimum value, and then increases. Optimum values of inlet hydraulic head, H_I and pressure surface parameter, S_R could be obtained. His study also found that the position of the elevated service

reservoir within the network is a important factor in cost optimization. If the position of the service reservoir is removed from the corner of a rectangular pipe network, towards the centre along the diagonal, the distance between the inlet point and the farthest point in the network is reduced, and for a specified head, the hydraulic gradient is increased. As a result, pipe cost is expected to be reduced. It was found that the total cost of the system is found to be 1.33 times more when the reservoir position is at one corner of the network than when it is at the centre.

4.4 CURRENT PRACTICE

From the study of five RWS schemes of the State, U.P., we see that the distribution networks were designed traditionally. In design, the tables based on Hazen Williams Formula were used. As the tables and graphs are used in design, there is a more chance to commit error in selecting a correct pipe diameter for the flow and friction slope conditions. There is no provision to check the error and it will be commulative giving more and more errors. For example, in the design of distribution network of Urwa, Part II, group of villages RWWS, a mistake has been committed in the beginning of a branch having starting node number 78. Due to this mistake the whole branch starting from node number 78 is unsafe from the

terminal pressure head point of view. There is no suitable method to analyse the distribution network after designing it. In other schemes under study, some are over-designed and some under-designed. So, there is an essential need of a proper analysis for the flow and pressure conditions of the network and a proper design procedure.

4.5 SUGGESTED IMPROVEMENT

By the analysis of distribution network we get the terminal pressure condition. Observing the pressure condition we have to change the pipe diameter upstream of the corresponding terminal node, to get the network improved. So, no doubt, the analysis designs the network system in other way.

The computer programme used for the analysis of the scheme here was used to design the network and make it as for as possible optimal. The final costs of the schemes were calculated after the suggested design. The computer programme can be efficiently used to make the system nearabout optimal which is previously arbitrarily designed. This has been done in Urwa, Part II, group of villages, RWSS, Allahabad.

4.6 A SUGGESTED LP METHOD

4.6.1 General

A method based on the critical path concept can be

developed for selection of the optimal sets of pipe sizes for optimization of branching networks by LP. The number of pipes of consecutive sizes in an optimal set depends upon the quality of optimality needed. Practically two pipe sizes are satisfactory for a system. For global optimality are can select four, or even more pipe sizes. Before going.to the critical path concept and behaviour of LP, we will be clear about some definitions.

Path

In branching system there is only one route to each demand node (terminal node) from the source. This route is called path.

Slope of Path

This is maximum available average friction slope. This is expressed as

$$S = \frac{H_o - H^{min}}{L_P} \tag{4.1}$$

where S = slope of the path

H_o = HGL at the source

H = minimum required HGL at the demand node

and L_P = length of the path

Critical Slope

The minimum of all the path-slopes is termed as critical path.

$$S_c = \text{Minimum} \frac{H_o - H^{min}}{L_P}, \text{giving } S_c \leq S \qquad (4.2)$$

Critical Path and Critical Node

The path having the maximum available average friction slope equal to the critical slope is termed as critical path and the node at the end of the critical path is termed as critical node.

Link

It consists of one or more pipes connected in series and has a constant flow and no branches.

4.6.2 LP Model

Decision Variable

As the resistance of a pipe and its cost are linear functions of its length, the different pipe lengths constituting a link are taken as the decision variables.

Objective Function

The objective function is to minimize the sum of the capital costs of the various links.

Constraints

(i) For all links the sum of the lengths of the pipes selected must equal the length of the link.

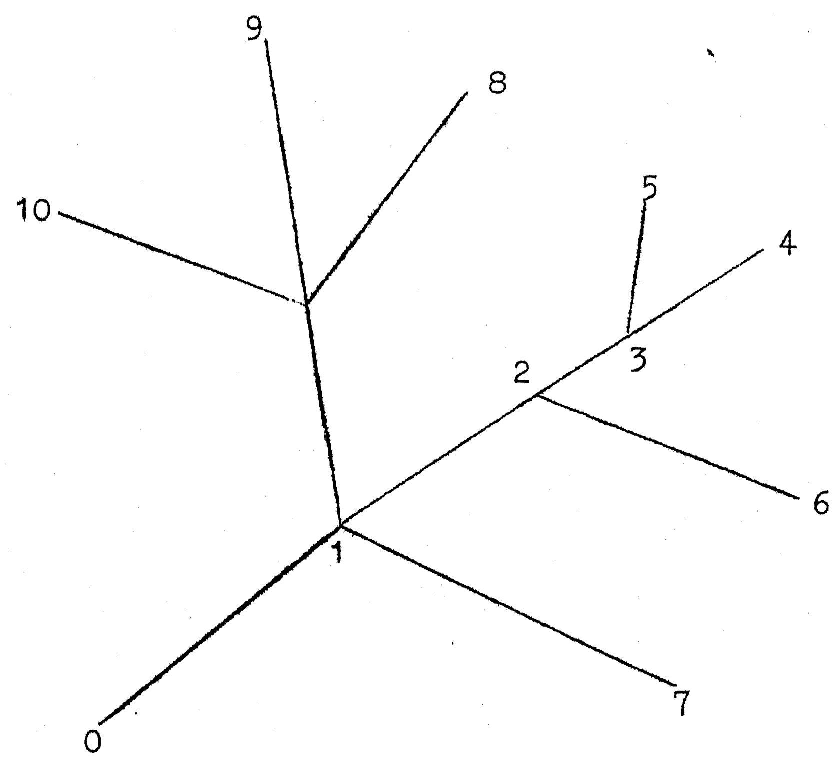


FIG. 4.1: BRANCHING DISTRIBUTION SYSTEM

(ii) At each demand node the available HGL value must be equal to or greater than the minimum required HGL value at the node.

(iii) All pipe-lengths must be non-negative.

By experience, a designer, who carries out the network optimization, selects generally an optimal set of two or three pipe sizes, but this set may not constitute the optimal set. So, critical path concept is suggested here to select optimal set of pipe sizes.

4.6.3 Critical Path Concept

Here, the critical path for the entire system is located. There will be so many paths as demand nodes. The critical one is chosen in the system. For a node i on the critical path, the proposed HGL value H_i will be given by

$$H_i = H_o - S_c \, L_{Pi} \qquad (4.3)$$

From equation (4.1)

$$H_i^{min} = H_o - S_i \, L_{Pi} \qquad (4.4)$$

From equations (4.3) and (4.4)

$$H_i \geq H_i^{min}$$

which satisfy the node HGL constraints of the optimization problem, for all the nodes on critical path.

Thus , when all the links on the critical path are provided with critical slope, the node HGL constraints for all the nodes on the critical path are satisfied, and the flow takes place along the other paths.

After deciding the critical path and estimating the HGL values for the nodes lying on it, the critical path is removed from the distribution system. This leaves behind distribution sub-systems of the first order. These distribution sub-systems emerge from the nodes of known HGL values and thus are treated as independent distribution subsystems for which critical subpaths are located and the HGL values for nodes lying on them are estimated. The procedure of obtaining the distribution subsytems of first and higher orders, locating the critical subpaths and estimating the HGL values for nodes lying on them is continued until the proposed friction slopes for all links of the entire system can be estimated.

Practically the commercial pipe sizes which have friction slopes equal to the immediate lower and higher values constitute the optimal set for each link.

4.6.4 Formulation

After getting the critical path, the diameter of all the links lying on that path will be calculated by

$$D = \left(\frac{10.69\, Q^{1.852}}{C^{1.852}\, S} \right)^{1/4.87}$$

where Q = pipe discharge, m^3/sec.

C = Hazen Williams constant

S = friction path slope

and D = internal diameter of the pipe in m

The set of two commercial pipe sizes having immediate lower and higher values than the calculated size will be optimal set.

4.6.5 Computer Programme

On the basis of this LP model based on critical path concept a computer programme in FORTRAN IV language was prepared. This consists of one main program and one subroutine dia. This has been created on the disk of IIT/K DEC 1090 system, and has been found to work satisfactorily. The programme is however in the initial stage of development and needs full testing . The details are available with Dr. K. Subramanya.

5 CONCLUSIONS AND RECOMMENDATIONS

Five rural water supply schemes under U.P. Jal Nigam were selected for the present study. Three tree type schemes are in district Allahabad named Girdkot, Ketehra and Urwa and two loop cum tree type schemes are in district Kanpur named Malasa and Rajpur. The topography of the areas where these schemes fall are more or less flat. Overall comparative study of these schemes has been done. The need for an efficient design and analysis of water distribution networks has been brought out.

These schemes were analysed by an efficient modified water distribution network system analysis computer programme. By the analysis of these schemes, it was found that some schemes were under-designed and some over-designed. These deficiencies of the existing schemes were removed with the help of the programme. By making suitable changes in the pipe line data of the schemes, in few trials we have got nearby optimized networks and final cost was calculated for each scheme. On the basis of the comparative study of the schemes, it has been found that the per capita expenditure for a typical scheme, is Rs. 105/- for the year 2001.

A computer method for the optimum design of tree type water distribution network has been indicated. This

method is based on critical path approach.

It has been found that:

i) There is scope for considerable improvement in the schemes to effect economy.

ii) Computer analysis and design is a necessity and the traditional methods of design have to give way to this.

iii) The analysis programme used in the present study is very fast, versatile, reliable and could be used by Jal Nigam and other organisations connected with water supply for obtaining status of their design/systems.

iv) There is a need for a computer based optimal water supply design programme.

LIST OF REFERENCES

1. Bhave, P.R., 'Economical Design of Single Source Distribution Networks by Critical Path Method,' Journal of IE (India), Env. Eng. Div., Vol.58, pt EN1, Oct., 1977, pp. 1-7.

2. Bhave, P.R., 'Critical Path Approach for the Design of Dead-End Gravity Distribution Systems,' Journal of IWWA, Bombay, India, Vol.8, No.1, Jan.-March,1976, pp.41-48.

3. Bhave, P.R., 'Selecting Pipe Sizes in Network-Optimization by LP ', Journal of the Hydraulics Division, ASCE, Vol.105, No. HY7, August, 1979, pp. 1019-1025.

4. Bhave, P.R., 'Node Flow Analysis of Serial Water Distribution Systems', Journal of IWWA, Vol.XII, No.1, Jan.-Mar.,1980, pp.17-23.

5. Chiplunkar, A.V. and Khanna, P., 'Optimal Design of Rural Water Supply Systems', Journal of IWWA, Vol.XII, No.2, April -June, 1980, pp. 205-212.

6. Civic Affairs, U.P. Jal Nigam, Vol.26, No.11, June,1979.

7. Deb, A.K., 'Optimization in Design of Pumping Systems' Journal of the Env. Eng. Div.,ASCE, Vol.104, No. EE1, Feb., 1978, pp. 127-136.

8. Deb, A.K., 'Optimization of Water Distribution Network Systems,' Journal of the Env. Eng. Div., Vol.102, No.EE4, Aug., 1976, pp.837-851.

9. Deb , A.K., 'Least Cost Design of Branched Pipe Network System,' Journal of the Env.,Eng. Div., ASCE, Vol.100, No. EE4, Aug.,1974, pp. 821-835.

10. Garde,R.J., and Mirajgaokar, A.G., Fluid Mechanics, Roorkee Publishing House Roorkee(India), 1972.

11. Khanna, P., and Swamee, P.K., 'Optimization of Water Distribution Networks,' Journal of the Institution of Engineers (India), Public Health Engineering Division, Vol.52, No.6, Part PH2, February, 1972, pp.54-56.

12. Khare, S.T., 'International Drinking Water Supply and Sanitation Decade (1980-1990),' Journal of IWWA, Vol.X, No.1, Jan.-March, 1978, pp.1-3.

13. Kumaresan, N., and Kumar Avadhesh, 'Approaches for Optimal Design of Branched Pipe System,' Journal of IWWA, Vol.XII, No.1, Jan.-March, 1980, pp.25-31.

14. Report, Girdkot Group of Villages Rural Water Supply Scheme, Allahabad, U.P. Jal Nigam.

15. Report, Ketehra Group of Villages Rural Water Supply Scheme, Allahabad, U.P. Jal Nigam.

16. Report, Urwa, Part II, Group of Villages Rural Water Supply Scheme, Allahabad, U.P. Jal Nigam.

17. Report, Malasa Group of Villages Rural Water Supply Scheme, Kanpur, U.P. Jal Nigam.

18. Report, Rajpur Group of Villages Rural Water Supply Scheme, Kanpur, U.P. Jal Nigam.

19. Streeter, V.L., and Wylie, E. Benjamin, Fluid Mechanics, McGraw-Hill Kogakusha, Ltd. International Student Edition, 1975.

20. Sundarsan, B.B., 'Drinking Water Supply Decade (1980-1990)-A Challenge,' Journal of Indian Water Works Association, Vol.XI,No.2,April-June,1979,pp.225-244.

21. Swamee, P.K., Kumar Virendra, and Khanna, P., 'Optimization of Dead End Water Distribution Systems,' Journal of the Env. Eng. Div., ASCE, Vol.99, No.EE2, Proc.Paper 9650, April, 1973, pp. 123-134.

22. Tasgaonkar, S.K., 'Norms for Design of Rural Piped Water Supply Schemes,' Journal of IWWA, Vo.X, No.1, Jan.-March, 1978, pp. 97-102.

23. Venkobachar, C. and Jain, R.K., 'Recent Trend in Rural Water Supply Technology,' Journal of IWWA, Vol.XI, No.3, July-Sept., 1979, pp. 323-326.

APPENDIX I - FEATURES OF NETWORK ANALYSIS PROGRAMME

Features of the programme can be listed as follows:

1. Any type of pipe system configuration can be handled.
2. The system can contain any number of storage tanks, pumps, valves, meters, fittings etc.
3. Pumps can be described by useful power or by inputing head-flow data from operating curves. Out of range pump operation is incorporated into the programme.
4. The system can have pressure regulating valves which isolate entire low pressure regions or various single pressure regulations described throughout the system.
5. Check valves, which allow flow in only one direction, can be included.
6. Flow units of CFS, GPM, MGD or SI can be used.
7. Data preparation is simple even for large systems.
8. Complete output is provided including pressures, elevations and grade lines at all junctions, head losses in lines and at all valves, pump heads, flowrates and velocities.
9. The procedure is relatively fast. Typical computer times for execution on DEC 1090 system at IIT Kanpur are as follows:

   For loop systems: 2-3 seconds for 100 pipes network
   6-7 seconds for 300 pipes network

For tree type systems : 1-2 seconds for 100 pipes network.

10. It has the characteristics to converge to a solution for all situations.

11. No assumptions (such as initial flowrates or pressures) are required.

12. Sparse matrix routines are used which minimize storage requirements and increase computer execution times.

13. A pipe system of p pipes requires approximately 50 p dimensioned storage (word) spaces.

The basis of the programme is a direct solution of the basic pipe system hydraulic equations using a linearization scheme[(A-1)] and sparse matrix methods to handle the non-linearization methods to solve the equations. It utilizes linear network theory.

Ref:(A-1): Wood, Don J., and Charles, Carl, O.A., 'Hydraulic Network Analysis Using Linear Theory,' Journal of Hydraulics Division, ASCE, Vol.98, No.HY7, Proc. Paper 9031, July 1972, pp. 1157-1170.

APPENDIX II - RESULTS OF ANALYSIS

Typical output results relating to the analysis of all five U.P. Jal Nigam schemes (A through E) are appended.

SCHEME 1

GIRDKOT, ZONE A, GROUP OF VILLAGES RURAL WATER SUPPLY SCHEME, ALLAHABAD

THIS SYSTEM HAS ONE OVER HEAD TANK

THIS SCHEME HAS 112 PIPES, 112 JUNCTIONS, 0 LOOP AND 1 FIXED GRADE NODE

THESE ARE THE RESULTS FOR THE FLOWS IN PIPES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	30.0	20.0	130.0	21.805	0.083	0.694	2.760	44.49
2	1	112	700.0	20.0	130.0	12.015	0.641	0.382	0.915	
3	112	2	610.0	15.0	130.0	12.015	2.266	0.680	3.716	
4	2	14	433.0	10.0	140.0	4.198	1.441	0.535	3.328	
5	14	15	300.0	5.0	140.0	0.710	1.086	0.361	3.619	
6	14	18	230.0	8.0	140.0	1.750	0.449	0.348	1.952	
7	18	19	50.0	5.0	140.0	0.681	0.167	0.347	3.349	
8	18	20	210.0	6.5	140.0	1.069	0.453	0.322	2.155	
9	20	21	50.0	2.5	140.0	0.097	0.133	0.198	2.665	
10	20	22	20.0	2.5	140.0	0.292	0.408	0.594	20.387	
11	14	23	1227.0	8.0	140.0	1.383	1.548	0.275	1.261	
12	23	24	255.0	5.0	140.0	0.583	0.642	0.297	2.517	
13	23	25	100.0	5.0	140.0	0.799	0.451	0.407	4.509	
14	2	3	57.0	15.0	130.0	7.817	0.096	0.442	1.676	
15	3	57	950.0	10.0	140.0	2.786	1.480	0.355	1.558	
16	57	58	130.0	4.0	140.0	0.389	0.458	0.309	3.521	
17	58	59	110.0	4.0	140.0	0.389	0.387	0.309	3.521	
18	59	60	90.0	4.0	140.0	0.389	0.317	0.309	3.521	
19	57	61	300.0	6.5	140.0	1.231	0.839	0.371	2.796	
20	61	62	100.0	5.0	140.0	0.648	0.305	0.330	3.053	
21	61	63	60.0	4.0	140.0	0.583	0.448	0.464	7.461	
22	57	64	80.0	6.5	140.0	1.167	0.203	0.352	2.532	
23	64	65	60.0	4.0	140.0	0.486	0.319	0.387	5.323	
24	64	66	27.0	5.0	140.0	0.583	0.068	0.297	2.517	
25	66	67	90.0	4.0	140.0	0.486	0.479	0.387	5.323	
26	3	4	478.0	12.5	130.0	5.030	0.861	0.410	1.800	
27	4	5	178.0	12.5	130.0	3.922	0.202	0.320	1.135	
28	5	26	256.0	2.5	140.0	0.194	2.463	0.396	9.621	
29	5	27	75.0	12.5	130.0	3.727	0.078	0.304	1.033	
30	27	28	90.0	2.5	140.0	0.194	0.866	0.396	9.621	
31	27	29	60.0	10.0	140.0	3.533	0.145	0.450	2.418	
32	29	30	90.0	2.5	140.0	0.194	0.866	0.396	9.621	
33	29	31	90.0	10.0	140.0	3.339	0.196	0.425	2.178	
34	31	6	565.0	10.0	140.0	2.174	0.556	0.277	0.984	
35	6	35	300.0	3.2	140.0	0.226	1.142	0.280	3.806	
36	35	36	98.0	2.5	140.0	0.117	0.366	0.238	3.736	
37	35	37	132.0	2.5	140.0	0.109	0.434	0.222	3.288	
38	6	7	427.0	8.0	140.0	1.262	0.455	0.251	1.065	
39	7	38	50.0	5.0	140.0	0.484	0.089	0.247	1.782	
40	38	39	100.0	5.0	140.0	0.484	0.178	0.247	1.782	
41	39	40	10.0	2.5	140.0	0.097	0.027	0.198	2.665	
42	39	41	20.0	2.5	140.0	0.095	0.051	0.194	2.567	
43	41	42	150.0	2.5	140.0	0.095	0.385	0.194	2.567	
44	7	43	150.0	6.5	140.0	0.778	0.179	0.234	1.195	
45	43	44	75.0	3.2	140.0	0.194	0.217	0.242	2.891	
46	43	45	60.0	4.0	140.0	0.389	0.211	0.309	3.521	
47	45	46	30.0	3.2	140.0	0.194	0.087	0.242	2.891	
48	46	47	30.0	2.5	140.0	0.097	0.080	0.198	2.665	
49	31	32	312.0	5.0	140.0	0.970	2.015	0.494	6.458	
50	32	33	69.0	4.0	140.0	0.486	0.474	0.387	5.323	
51	33	34	167.0	2.5	140.0	0.097	0.432	0.198	2.665	
52	4	48	630.0	6.5	140.0	1.108	1.451	0.334	2.302	
53	48	49	33.0	6.5	140.0	1.108	0.076	0.334	2.302	
54	49	50	60.0	5.0	140.0	0.914	0.347	0.465	5.780	
55	50	51	60.0	4.0	140.0	0.389	0.211	0.309	3.521	
56	50	52	30.0	4.0	140.0	0.525	0.184	0.418	6.138	
57	52	53	20.0	2.5	140.0	0.136	0.099	0.277	4.970	
58	52	54	20.0	4.0	140.0	0.389	0.070	0.309	3.521	
59	49	55	60.0	3.2	140.0	0.194	0.173	0.242	2.891	
60	55	56	170.0	2.5	140.0	0.097	0.453	0.198	2.665	
61	1	68	1180.0	20.0	130.0	9.790	0.739	0.312	0.626	
62	68	69	290.0	4.0	140.0	0.389	1.021	0.309	3.521	
63	[illegible]	[illegible]	400.0	15.0	130.0	9.401	0.944	0.532	2.359	
64	[illegible]	70	300.0	8.0	140.0	3.105	1.694	0.618	5.645	
65	70	71	205.0	6.5	140.0	2.133	1.587	0.643	7.741	
66	71	72	270.0	5.0	140.0	0.972	1.750	0.495	6.482	
67	[illegible]	[illegible]	400.0	12.5	130.0	6.296	1.091	0.513	2.728	
68	[illegible]	[illegible]	305.0	10.0	140.0	2.929	0.523	0.373	1.709	

69	10	73	500.0	6.5	140.0	1.264	1.468	0.381	2.936
70	73	74	90.0	4.0	140.0	0.583	0.671	0.464	7.461
71	73	75	300.0	5.0	140.0	0.681	1.005	0.347	3.348
72	10	11	230.0	8.0	140.0	1.664	0.409	0.331	1.779
73	11	12	588.0	8.0	140.0	1.664	1.046	0.331	1.779
74	12	97	72.0	2.5	140.0	0.091	0.171	0.186	2.377
75	12	13	290.0	8.0	140.0	1.573	0.465	0.313	1.602
76	13	98	50.0	8.0	140.0	1.573	0.080	0.313	1.602
77	98	99	170.0	5.0	140.0	0.395	0.208	0.201	1.221
78	99	100	50.0	3.2	140.0	0.194	0.145	0.242	2.891
79	100	101	80.0	2.5	140.0	0.097	0.213	0.198	2.665
80	99	102	60.0	4.0	140.0	0.200	0.062	0.159	1.030
81	102	103	580.0	3.2	140.0	0.103	0.518	0.128	0.892
82	103	104	60.0	2.5	140.0	0.103	0.178	0.210	2.969
83	98	105	180.0	5.0	140.0	0.692	0.622	0.353	3.455
84	105	106	30.0	5.0	140.0	0.692	0.104	0.353	3.455
85	106	107	105.0	5.0	140.0	0.634	0.308	0.323	2.936
86	107	110	30.0	2.5	140.0	0.070	0.044	0.143	1.450
87	110	111	350.0	2.5	140.0	0.019	0.047	0.040	0.135
88	107	109	100.0	4.0	140.0	0.389	0.352	0.309	3.521
89	107	108	105.0	3.2	140.0	0.175	0.250	0.218	2.379
90	9	76	272.0	10.0	140.0	3.368	0.602	0.429	2.213
91	76	77	60.0	2.5	140.0	0.156	0.382	0.317	6.365
92	76	78	20.0	2.5	140.0	0.039	0.010	0.079	0.488
93	76	79	300.0	10.0	140.0	3.173	0.595	0.404	1.982
94	79	80	130.0	2.5	140.0	0.117	0.486	0.238	3.736
95	79	81	310.0	10.0	140.0	2.676	0.448	0.341	1.445
96	81	82	890.0	2.5	140.0	0.033	0.322	0.067	0.362
97	81	83	1000.0	10.0	140.0	2.643	1.412	0.336	1.412
98	83	84	78.0	4.0	140.0	0.467	0.385	0.371	4.935
99	83	85	70.0	2.5	140.0	0.097	0.187	0.198	2.665
100	83	86	195.0	10.0	140.0	2.079	0.177	0.265	0.905
101	86	87	80.0	2.5	140.0	0.049	0.059	0.099	0.738
102	86	88	540.0	10.0	140.0	2.030	0.468	0.258	0.867
103	88	89	90.0	4.0	140.0	0.486	0.479	0.387	5.323
104	88	90	270.0	8.0	140.0	1.495	0.394	0.297	1.458
105	90	91	40.0	3.2	140.0	0.194	0.116	0.242	2.891
106	90	92	60.0	8.0	140.0	1.301	0.068	0.259	1.127
107	93	93	220.0	8.0	140.0	1.204	0.215	0.239	0.976
108	93	94	90.0	5.0	140.0	0.523	0.185	0.266	2.056
109	93	95	300.0	6.5	140.0	0.681	0.280	0.205	0.933
110	95	96	60.0	6.5	140.0	0.681	0.056	0.205	0.933
111	15	16	40.0	3.2	140.0	0.389	0.418	0.484	10.438
112	15	17	60.0	3.2	140.0	0.321	0.439	0.399	7.310

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	44.407	29.440	14.97
2	0.00000	41.500	29.250	12.25
3	0.00000	41.404	29.370	12.03
4	0.00000	40.544	30.710	9.83
5	0.00000	40.342	30.430	9.91
6	0.68639	39.367	31.420	7.95
7	0.00000	38.913	31.420	7.49
8	0.00000	42.724	29.440	13.28
9	0.00000	41.633	30.440	11.19
10	0.00000	41.110	30.300	10.81
11	0.00000	40.701	30.180	10.52
12	0.00000	39.655	30.400	9.26
13	0.00000	39.191	30.600	8.59
14	0.35583	40.059	30.270	9.79
15	0.00000	38.973	30.530	8.44
16	0.38889	38.556	30.350	8.21
17	0.32083	38.535	30.220	8.31
18	0.00000	39.610	30.220	9.39
19	0.58056	39.443	30.220	9.22
20	0.58056	39.157	30.280	8.88
21	0.09722	39.024	30.300	8.72
22	0.29167	38.750	30.300	8.45
23	0.00000	38.511	30.100	8.41
24	0.58333	37.869	30.000	7.87
25	0.79917	38.060	30.100	7.96
26	0.19444	37.879	32.390	5.49
27	0.00000	40.264	30.130	10.13
28	0.19444	39.398	30.130	9.27
29	0.00000	40.119	30.130	9.99
30	0.19444	39.253	30.130	9.12
31	0.19444	39.923	30.130	9.79
32	0.48417	37.908	31.100	6.81
33	0.38889	37.435	30.000	7.43
34	0.09722	37.003	30.370	6.63
35	0.00000	38.225	31.130	7.10
36	0.11667	37.859	30.170	7.69
37	0.10889	37.792	31.260	6.53
38	0.00000	38.8[illegible]	31.170	7.6[illegible]

39	0.29167	38.645	31.000	7.65
40	0.09722	38.619	31.490	7.13
41	0.00000	38.594	31.490	7.10
42	0.09528	38.209	31.490	6.72
43	0.19444	38.733	31.490	7.24
44	0.19444	38.516	31.490	7.03
45	0.19444	38.522	31.490	7.03
46	0.09722	38.435	31.490	6.95
47	0.09722	38.355	31.490	6.87
48	0.00000	39.093	30.430	8.66
49	0.00000	39.017	30.520	8.50
50	0.00000	38.671	30.400	8.27
51	0.38889	38.459	30.570	7.89
52	0.00000	38.486	30.400	8.09
53	0.13611	38.387	30.430	7.96
54	0.38889	38.416	30.400	8.02
55	0.09722	38.844	30.520	8.32
56	0.09722	38.391	30.520	7.87
57	0.00000	39.924	29.040	10.88
58	0.00000	39.467	29.500	9.97
59	0.00000	39.079	29.450	9.63
60	0.38889	38.762	29.450	9.31
61	0.00000	39.086	29.600	9.49
62	0.64750	38.780	29.500	9.28
63	0.58333	38.638	29.500	9.14
64	0.09722	39.722	29.400	10.32
65	0.48611	39.402	29.500	9.90
66	0.09722	39.654	29.770	9.88
67	0.48611	39.175	29.770	9.40
68	0.00000	43.668	29.440	14.23
69	0.38889	42.647	29.660	12.99
70	0.97222	41.031	29.500	11.53
71	1.16083	39.444	29.500	9.94
72	0.97222	37.694	29.560	8.13
73	0.00000	39.642	30.600	9.04
74	0.58333	38.971	30.500	8.47
75	0.68056	38.638	28.590	10.05
76	0.00000	41.031	30.100	10.93
77	0.15556	40.649	29.800	10.85
78	0.03889	41.021	30.100	10.92
79	0.38111	40.436	29.500	10.94
80	0.11667	39.951	29.310	10.64
81	0.00000	39.988	29.430	10.56
82	0.03306	39.667	28.250	11.42
83	0.00000	38.576	30.040	8.54
84	0.46667	38.191	30.710	7.48
85	0.09722	38.390	29.850	8.54
86	0.00000	38.400	30.170	8.23
87	0.04861	38.341	30.040	8.30
88	0.04861	37.932	30.150	7.78
89	0.48611	37.453	30.200	7.25
90	0.00000	37.538	30.200	7.34
91	0.19444	37.422	30.100	7.32
92	0.09722	37.470	30.200	7.27
93	0.00000	37.256	30.300	6.96
94	0.52306	37.070	30.200	6.87
95	0.00000	36.976	30.300	6.68
96	0.68056	36.920	30.200	6.72
97	0.09139	39.484	30.630	8.85
98	0.48611	39.111	30.600	8.51
99	0.00000	38.903	30.470	8.43
100	0.09722	38.759	30.600	8.16
101	0.09722	38.545	30.600	7.95
102	0.09722	38.841	30.470	8.37
103	0.00000	38.324	30.770	7.55
104	0.10306	38.146	30.960	7.19
105	0.00000	38.489	30.890	7.60
106	0.05833	38.385	30.890	7.50
107	0.00000	38.077	30.700	7.38
108	0.17500	37.827	30.500	7.33
109	0.38889	37.725	30.690	7.03
110	0.05056	38.033	30.700	7.33
111	0.01944	37.986	30.690	7.30
112	0.00000	43.766	29.250	14.52

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	55.00	0.0	0.00
20.0	130.0	40.00	1910.0	76400.00
15.0	130.0	30.00	1067.0	32010.00
12.5	130.0	25.00	1131.0	28275.00
10.0	140.0	17.80	5021.0	89373.80
8.0	140.0	12.70	3892.0	49428.40

5.0	140.0	7.00	2499.0	17493.00
4.0	140.0	4.70	1507.0	7082.90
3.2	140.0	4.15	1340.0	5561.00
2.5	140.0	4.10	3140.0	12874.00
		TOTAL COST=		342437.70

THE FOLLOWING CHANGES IN SYSTEM DATA ARE MADE

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS
28	5	26	256.0	4.0	140.0
49	31	32	312.0	6.5	140.0
51	33	34	162.0	3.2	140.0
35	6	35	300.0	4.0	140.0
42	39	41	20.0	3.2	140.0
43	41	42	150.0	3.2	140.0
46	43	45	60.0	5.0	140.0
48	46	47	30.0	3.2	140.0
107	92	93	220.0	10.0	140.0
109	93	95	300.0	8.0	140.0
89	107	108	105.0	2.5	140.0
70	73	74	90.0	3.2	140.0
71	73	75	300.0	3.2	140.0
66	71	72	270.0	3.2	140.0
62	68	69	290.0	2.5	140.0
98	83	84	78.0	3.2	140.0
103	88	89	90.0	3.2	140.0
105	90	91	40.0	2.5	140.0
7	18	19	50.0	3.2	140.0
111	15	16	40.0	2.5	140.0
112	15	17	60.0	2.5	140.0
12	23	24	255.0	4.0	140.0
13	23	25	100.0	4.0	140.0
20	61	62	100.0	3.2	140.0
21	61	63	60.0	2.5	140.0
18	59	60	90.0	2.5	140.0
23	64	65	60.0	2.5	140.0
25	66	67	90.0	2.5	140.0
55	50	51	60.0	3.2	140.0
58	52	54	20.0	2.5	140.0

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	30.0	20.0	130.0	21.805	0.083	0.694	2.760	44.49
2	1	112	700.0	20.0	130.0	12.015	0.641	0.382	0.915	
3	112	2	610.0	15.0	130.0	12.015	2.266	0.680	3.716	
4	2	14	433.0	10.0	140.0	4.198	1.441	0.535	3.328	
5	14	15	300.0	5.0	140.0	0.710	1.086	0.361	3.619	
6	14	18	230.0	8.0	140.0	1.750	0.449	0.348	1.952	
7	18	19	50.0	3.2	140.0	0.681	1.471	0.846	29.426	
8	18	20	210.0	6.5	140.0	1.069	0.453	0.322	2.155	
9	20	21	50.0	2.5	140.0	0.097	0.133	0.198	2.665	
10	20	22	20.0	2.5	140.0	0.292	0.408	0.594	20.387	
11	14	23	1227.0	8.0	140.0	1.383	1.548	0.275	1.261	
12	23	24	255.0	4.0	140.0	0.583	1.903	0.464	7.461	
13	23	25	100.0	4.0	140.0	0.799	1.337	0.636	13.366	
14	2	3	57.0	15.0	130.0	7.917	0.096	0.442	1.676	
15	3	57	950.0	10.0	140.0	2.786	1.480	0.355	1.558	
16	57	58	130.0	4.0	140.0	0.389	0.458	0.309	3.521	
17	58	59	110.0	4.0	140.0	0.389	0.387	0.309	3.521	
18	59	60	90.0	2.5	140.0	0.389	3.126	0.792	34.733	
19	57	61	300.0	6.5	140.0	1.231	0.839	0.371	2.796	
20	61	62	100.0	3.2	140.0	0.648	2.683	0.805	26.834	
21	61	63	60.0	2.5	140.0	0.583	4.416	1.188	73.596	
22	57	64	80.0	6.5	140.0	1.167	0.203	0.352	2.532	
23	64	65	60.0	2.5	140.0	0.486	3.150	0.990	52.507	
24	64	66	27.0	5.0	140.0	0.583	0.068	0.297	2.517	
25	66	67	90.0	2.5	140.0	0.486	4.726	0.990	52.507	
26	3	4	478.0	12.5	130.0	5.030	0.861	0.410	1.800	
27	4	5	178.0	12.5	130.0	3.922	0.202	0.320	1.135	
28	5	26	256.0	4.0	140.0	0.194	0.250	0.155	0.975	
29	5	27	75.0	12.5	130.0	3.727	0.078	0.304	1.033	
30	27	28	90.0	2.5	140.0	0.194	0.866	0.396	9.621	
31	27	29	60.0	10.0	140.0	3.533	0.145	0.450	2.418	
32	29	30	90.0	2.5	140.0	0.194	0.866	0.396	9.621	
33	29	31	90.0	10.0	140.0	3.339	0.196	0.425	2.178	
34	31	6	565.0	10.0	140.0	2.174	0.556	0.277	0.984	
35	6	35	300.0	4.0	140.0	0.226	0.385	0.179	1.284	
36	35	36	98.0	2.5	140.0	0.117	0.366	0.238	3.736	
37	35	37	132.0	2.5	140.0	0.109	0.434	0.222	3.288	
38	6	7	427.0	8.0	140.0	1.262	0.455	0.251	1.065	
39	7	38	50.0	5.0	140.0	0.484	0.089	0.247	1.782	
40	38	39	100.0	5.0	140.0	0.484	0.178	0.247	1.782	
41	39	40	10.0	2.5	140.0	0.097	0.027	0.198	2.665	
42	39	41	20.0	3.2	140.0	0.095	0.015	0.118	0.772	
43	41	42	150.0	3.2	140.0	0.095	0.116	0.118	0.772	
44	7	43	150.0	6.5	140.0	0.778	0.179	0.234	1.195	
45	43	44	75.0	3.2	140.0	[illegible]	[illegible]	[illegible]	[illegible]	

46	43	45	60.0	5.0	140.0	0.389	0.071	0.198	1.188
47	45	46	30.0	3.2	140.0	0.194	0.087	0.242	2.891
48	46	47	30.0	3.2	140.0	0.097	0.024	0.121	0.801
49	31	32	312.0	6.5	140.0	0.970	0.561	0.292	1.800
50	32	33	89.0	4.0	140.0	0.486	0.474	0.387	5.323
51	33	34	162.0	3.2	140.0	0.097	0.130	0.121	0.801
52	4	48	630.0	6.5	140.0	1.108	1.451	0.334	2.302
53	48	49	33.0	6.5	140.0	1.108	0.076	0.334	2.302
54	49	50	60.0	5.0	140.0	0.914	0.347	0.465	5.780
55	50	51	60.0	3.2	140.0	0.389	0.626	0.484	10.438
56	50	52	30.0	4.0	140.0	0.525	0.184	0.418	6.138
57	52	53	20.0	2.5	140.0	0.136	0.099	0.277	4.970
58	52	54	20.0	2.5	140.0	0.389	0.695	0.792	34.733
59	49	55	60.0	3.2	140.0	0.194	0.173	0.242	2.891
60	55	56	170.0	2.5	140.0	0.097	0.453	0.198	2.665
61	1	68	1180.0	20.0	130.0	9.790	0.739	0.312	0.626
62	68	69	290.0	2.5	140.0	0.389	10.073	0.792	34.733
63	68	9	400.0	15.0	130.0	9.401	0.944	0.532	2.359
64	8	70	300.0	8.0	140.0	3.105	1.694	0.618	5.645
65	70	71	205.0	6.5	140.0	2.133	1.587	0.643	7.741
66	71	72	270.0	3.2	140.0	0.972	15.381	1.209	56.965
67	8	9	400.0	12.5	130.0	6.296	1.091	0.513	2.728
68	9	10	306.0	10.0	140.0	2.928	0.523	0.373	1.708
69	10	73	500.0	6.5	140.0	1.264	1.468	0.381	2.936
70	73	74	90.0	3.2	140.0	0.583	1.991	0.725	22.118
71	73	75	300.0	3.2	140.0	0.681	8.828	0.846	29.426
72	10	11	230.0	8.0	140.0	1.664	0.409	0.331	1.779
73	11	12	588.0	8.0	140.0	1.664	1.046	0.331	1.779
74	12	97	72.0	2.5	140.0	0.091	0.171	0.186	2.377
75	12	13	290.0	8.0	140.0	1.573	0.465	0.313	1.602
76	13	98	50.0	8.0	140.0	1.573	0.080	0.313	1.602
77	98	99	170.0	5.0	140.0	0.395	0.208	0.201	1.221
78	99	100	50.0	3.2	140.0	0.194	0.145	0.242	2.891
79	100	101	80.0	2.5	140.0	0.097	0.213	0.198	2.665
80	99	102	60.0	4.0	140.0	0.200	0.062	0.159	1.030
81	102	103	580.0	3.2	140.0	0.103	0.518	0.128	0.892
82	103	104	60.0	2.5	140.0	0.103	0.178	0.210	2.969
83	98	105	180.0	5.0	140.0	0.692	0.622	0.353	3.455
84	105	106	30.0	5.0	140.0	0.692	0.104	0.353	3.455
85	106	107	105.0	5.0	140.0	0.634	0.308	0.323	2.936
86	107	110	30.0	2.5	140.0	0.070	0.044	0.143	1.450
87	110	111	350.0	2.5	140.0	0.019	0.047	0.040	0.135
88	107	109	100.0	4.0	140.0	0.389	0.352	0.309	3.521
89	107	108	105.0	2.5	140.0	0.175	0.831	0.357	7.916
90	9	76	272.0	10.0	140.0	3.368	0.602	0.429	2.213
91	76	77	60.0	2.5	140.0	0.156	0.382	0.317	6.365
92	76	78	20.0	2.5	140.0	0.039	0.010	0.079	0.488
93	76	79	300.0	10.0	140.0	3.173	0.595	0.404	1.982
94	79	80	130.0	2.5	140.0	0.117	0.486	0.238	3.736
95	79	81	310.0	10.0	140.0	2.676	0.448	0.341	1.445
96	81	82	890.0	2.5	140.0	0.033	0.322	0.067	0.362
97	81	83	1000.0	10.0	140.0	2.643	1.412	0.336	1.412
98	83	84	78.0	3.2	140.0	0.467	1.141	0.580	14.631
99	83	85	70.0	2.5	140.0	0.097	0.187	0.198	2.665
100	83	86	195.0	10.0	140.0	2.079	0.177	0.265	0.905
101	86	87	80.0	2.5	140.0	0.049	0.059	0.099	0.738
102	86	88	540.0	10.0	140.0	2.030	0.468	0.258	0.867
103	88	89	90.0	3.2	140.0	0.486	1.420	0.604	15.780
104	88	90	270.0	8.0	140.0	1.495	0.394	0.297	1.458
105	90	91	40.0	2.5	140.0	0.194	0.385	0.396	9.621
106	90	92	60.0	8.0	140.0	1.301	0.068	0.259	1.127
107	92	93	220.0	10.0	140.0	1.204	0.072	0.153	0.329
108	93	94	90.0	5.0	140.0	0.523	0.185	0.266	2.056
109	93	95	300.0	8.0	140.0	0.681	0.102	0.135	0.339
110	95	96	60.0	6.5	140.0	0.681	0.056	0.205	0.933
111	15	16	40.0	2.5	140.0	0.389	1.389	0.792	34.733
112	16	17	60.0	2.5	140.0	0.321	1.459	0.654	24.322

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	44.407	29.440	14.97
2	0.00000	41.500	29.250	12.25
3	0.00000	41.404	29.370	12.03
4	0.00000	40.544	30.710	9.83
5	0.00000	40.342	30.430	9.91
6	0.68639	39.367	31.420	7.95
7	0.00000	38.913	31.420	7.49
8	0.00000	42.724	29.440	13.28
9	0.00000	41.633	30.440	11.19
10	0.00000	41.110	30.300	10.81
11	0.00000	40.701	30.180	10.52
12	0.00000	39.655	30.400	9.26
13	0.00000	39.191	30.600	8.59
14	0.35583	40.059	30.270	9.79
15	0.00000	38.973	30.530	8.44

16	0.38889	37.584	30.350	7.23
17	0.32083	37.514	30.220	7.29
18	0.00000	39.610	30.220	9.39
19	0.68056	38.139	30.220	7.92
20	0.68056	39.157	30.280	8.88
21	0.09722	39.024	30.300	8.72
22	0.29167	38.750	30.300	8.45
23	0.00000	38.511	30.100	8.41
24	0.58333	36.609	30.000	6.61
25	0.79917	37.175	30.100	7.07
26	0.19444	40.092	32.390	7.70
27	0.00000	40.264	30.130	10.13
28	0.19444	39.398	30.130	9.27
29	0.00000	40.119	30.130	9.99
30	0.19444	39.253	30.130	9.12
31	0.19444	39.923	30.130	9.79
32	0.48417	39.362	31.100	8.26
33	0.38889	38.888	30.000	8.89
34	0.09722	38.758	30.370	8.39
35	0.00000	38.982	31.130	7.85
36	0.11667	38.616	30.170	8.45
37	0.10889	38.548	31.260	7.29
38	0.00000	38.823	31.170	7.65
39	0.29167	38.645	31.000	7.65
40	0.09722	38.619	31.490	7.13
41	0.00000	38.630	31.490	7.14
42	0.09528	38.514	31.490	7.02
43	0.19444	38.733	31.490	7.24
44	0.19444	38.516	31.490	7.03
45	0.19444	38.662	31.490	7.17
46	0.09722	38.575	31.490	7.09
47	0.09722	38.551	31.490	7.06
48	0.00000	39.093	30.430	8.66
49	0.00000	39.017	30.520	8.50
50	0.00000	38.671	30.400	8.27
51	0.38889	38.044	30.570	7.47
52	0.00000	38.486	30.400	8.09
53	0.13611	38.387	30.430	7.96
54	0.38889	37.792	30.400	7.39
55	0.09722	38.844	30.520	8.32
56	0.09722	38.391	30.520	7.87
57	0.00000	39.924	29.040	10.88
58	0.00000	39.467	29.500	9.97
59	0.00000	39.079	29.450	9.63
60	0.38889	35.953	29.450	6.50
61	0.00000	39.086	29.600	9.49
62	0.64750	36.402	29.500	6.90
63	0.58333	34.670	29.500	5.17
64	0.09722	39.722	29.400	10.32
65	0.48611	36.571	29.500	7.07
66	0.09722	39.654	29.770	9.88
67	0.48611	34.928	29.770	5.16
68	0.00000	43.668	29.440	14.23
69	0.38889	33.595	29.660	3.94
70	0.97222	41.031	29.500	11.53
71	1.16083	39.444	29.500	9.94
72	0.97222	24.063	29.560	-5.50
73	0.00000	39.642	30.600	9.04
74	0.58333	37.652	30.500	7.15
75	0.68056	30.814	28.590	2.22
76	0.00000	41.031	30.100	10.93
77	0.15556	40.649	29.800	10.85
78	0.03889	41.021	30.100	10.92
79	0.38111	40.436	29.500	10.94
80	0.11667	39.951	29.310	10.64
81	0.00000	39.988	29.430	10.56
82	0.03306	39.667	28.250	11.42
83	0.00000	38.576	30.040	8.54
84	0.46667	37.435	30.710	6.72
85	0.09722	38.390	29.850	8.54
86	0.00000	38.400	30.170	8.23
87	0.04861	38.341	30.040	8.30
88	0.04861	37.932	30.150	7.78
89	0.48611	36.511	30.200	6.31
90	0.00000	37.538	30.200	7.34
91	0.19444	37.153	30.100	7.05
92	0.09722	37.470	30.200	7.27
93	0.00000	37.398	30.300	7.10
94	0.52306	37.213	30.200	7.01
95	0.00000	37.296	30.300	7.00
96	0.68056	37.240	30.200	7.04
97	0.09139	39.484	30.630	8.85
98	0.48611	39.111	30.600	8.51
99	0.00000	38.903	30.470	8.43
100	0.09722	38.759	30.600	8.16
101	0.09722	38.545	30.600	7.95
102	0.09722	38.841	30.470	8.37
103	0.00000	38.324	30.770	7.55
104	0.10306	38.146	30.960	7.19

105	0.00000	38.489	30.890	7.60
106	0.05833	38.385	30.890	7.50
107	0.00000	38.077	30.700	7.38
108	0.17500	37.246	30.500	6.75
109	0.38889	37.725	30.690	7.03
110	0.05056	38.033	30.700	7.33
111	0.01944	37.986	30.690	7.30
112	0.00000	43.766	29.250	14.52

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	55.00	0.0	0.00
20.0	130.0	40.00	1910.0	76400.00
15.0	130.0	30.00	1067.0	32010.00
12.5	130.0	25.00	1131.0	28275.00
10.0	140.0	17.80	5241.0	93289.80
8.0	140.0	12.70	3972.0	50444.40
6.5	140.0	9.70	2480.0	24056.00
5.0	140.0	7.00	1172.0	8204.00
4.0	140.0	4.70	1430.0	6721.00
3.2	140.0	4.15	2195.0	9109.25
2.5	140.0	4.10	3377.0	13845.70

TOTAL COST= 342355.15

THE FOLLOWING CHANGES IN SYSTEM DATA ARE MADE

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS
89	107	108	105.0	3.2	140.0
71	73	75	300.0	4.0	140.0
66	71	72	270.0	5.0	140.0
62	68	69	290.0	3.2	140.0
98	83	84	78.0	4.0	140.0
103	88	89	90.0	4.0	140.0
20	61	62	100.0	4.0	140.0
21	61	63	60.0	3.2	140.0
18	59	60	90.0	3.2	140.0
25	66	67	90.0	3.2	140.0
12	23	24	255.0	5.0	140.0

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	30.0	20.0	130.0	21.805	0.083	0.694	2.760	44.49
2	1	112	700.0	20.0	130.0	12.015	0.641	0.382	0.915	
3	112	2	610.0	15.0	130.0	12.015	2.266	0.680	3.716	
4	2	14	433.0	10.0	140.0	4.198	1.441	0.535	3.328	
5	14	15	300.0	5.0	140.0	0.710	1.086	0.361	3.619	
6	14	18	230.0	8.0	140.0	1.750	0.449	0.348	1.952	
7	18	19	50.0	3.2	140.0	0.681	1.471	0.846	29.426	
8	18	20	210.0	6.5	140.0	1.069	0.453	0.322	2.155	
9	20	21	50.0	2.5	140.0	0.097	0.133	0.198	2.665	
10	20	22	20.0	2.5	140.0	0.292	0.408	0.594	20.387	
11	14	23	1227.0	8.0	140.0	1.383	1.548	0.275	1.261	
12	23	24	255.0	5.0	140.0	0.583	0.642	0.297	2.517	
13	23	25	100.0	4.0	140.0	0.799	1.337	0.636	13.366	
14	2	3	57.0	15.0	130.0	7.817	0.096	0.442	1.676	
15	3	57	950.0	10.0	140.0	2.786	1.480	0.355	1.558	
16	57	58	130.0	4.0	140.0	0.389	0.458	0.309	3.521	
17	58	59	110.0	4.0	140.0	0.389	0.387	0.309	3.521	
18	59	60	90.0	3.2	140.0	0.389	0.939	0.484	10.438	
19	57	61	300.0	6.5	140.0	1.231	0.839	0.371	2.796	
20	61	62	100.0	4.0	140.0	0.648	0.905	0.515	9.052	
21	61	63	60.0	3.2	140.0	0.583	1.327	0.725	22.118	
22	57	64	80.0	6.5	140.0	1.167	0.203	0.352	2.532	
23	64	65	60.0	2.5	140.0	0.486	3.150	0.990	52.507	
24	64	66	27.0	5.0	140.0	0.583	0.068	0.297	2.517	
25	66	67	90.0	3.2	140.0	0.486	1.420	0.604	15.780	
26	3	4	478.0	12.5	130.0	5.030	0.861	0.410	1.800	
27	4	5	178.0	12.5	130.0	3.922	0.202	0.320	1.135	
28	5	26	256.0	4.0	140.0	0.194	0.250	0.155	0.975	
29	5	27	75.0	12.5	130.0	3.727	0.078	0.304	1.033	
30	27	28	90.0	2.5	140.0	0.194	0.866	0.396	9.621	
31	27	29	60.0	10.0	140.0	3.533	0.145	0.450	2.418	
32	29	30	90.0	2.5	140.0	0.194	0.866	0.396	9.621	
33	29	31	90.0	10.0	140.0	3.339	0.196	0.425	2.178	
34	31	6	565.0	10.0	140.0	2.174	0.556	0.277	0.984	
35	6	35	300.0	4.0	140.0	0.226	0.385	0.179	1.284	
36	35	36	98.0	2.5	140.0	0.117	0.366	0.238	3.736	
37	35	37	132.0	2.5	140.0	0.109	0.434	0.222	3.288	
38	6	7	427.0	8.0	140.0	1.262	0.455	0.251	1.065	
39	7	38	50.0	5.0	140.0	0.484	0.089	0.247	1.782	
40	38	39	100.0	5.0	140.0	0.484	0.178	0.247	1.782	
41	39	40	10.0	2.5	140.0	0.097	0.027	0.198	2.665	
42	39	41	20.0	3.2	140.0	0.095	0.015	0.118	0.772	
43	41	42	150.0	3.2	140.0	0.095	0.116	0.118	0.772	
44	7	43	150.0	6.5	140.0	0.778	0.179	0.234	1.195	
45	43	44	75.0	3.2	140.0	0.194	0.217	0.242	2.891	
46	43	45	60.0	5.0	140.0	0.389	0.071	0.198	1.188	
47	45	46	30.0	3.2	140.0	0.194	0.087	0.242	2.891	
48	46	47	30.0	3.2	140.0	0.097	0.024	0.121	0.801	
49	31	32	312.0	6.5	140.0	0.970	0.561	0.292	1.800	
50	32	33	89.0	4.0	140.0	0.486	0.474	0.387	5.323	
51	33	34	162.0	3.2	140.0	0.097	0.130	0.121	0.801	
52	4	48	630.0	6.5	140.0	1.108	1.451	0.334	2.302	
53	48	49	33.0	6.5	140.0	1.108	0.076	0.334	2.302	
54	49	50	60.0	5.0	140.0	0.914	0.347	0.465	5.780	
55	50	51	60.0	3.2	140.0	0.389	0.626	0.484	10.438	
56	50	52	30.0	4.0	140.0	0.525	0.184	0.418	6.138	
57	52	53	20.0	2.5	140.0	0.136	0.099	0.277	4.970	
58	52	54	20.0	2.5	140.0	0.389	0.695	0.792	34.733	
59	49	55	60.0	3.2	140.0	0.194	0.173	0.242	2.891	
60	55	56	170.0	2.5	140.0	0.097	0.453	0.198	2.665	
61	1	68	1180.0	20.0	130.0	9.790	0.739	0.312	0.626	
62	68	69	290.0	3.2	140.0	0.389	3.027	0.484	10.438	
63	68	8	400.0	15.0	130.0	9.401	0.944	0.532	2.359	
64	8	70	300.0	8.0	140.0	3.105	1.694	[illegible]	[illegible]	

65	70	71	205.0	6.5	140.0	2.133	1.587	0.643	7.741
66	71	72	270.0	5.0	140.0	0.972	1.750	0.495	6.482
67	8	9	400.0	12.5	130.0	6.296	1.091	0.513	2.728
68	9	10	306.0	10.0	140.0	2.928	0.523	0.373	1.708
69	10	73	500.0	6.5	140.0	1.264	1.468	0.381	2.936
70	73	74	90.0	3.2	140.0	0.583	1.991	0.725	22.118
71	73	75	300.0	4.0	140.0	0.681	2.978	0.542	9.926
72	10	11	230.0	8.0	140.0	1.664	0.409	0.331	1.779
73	11	12	588.0	8.0	140.0	1.664	1.046	0.331	1.779
74	12	97	72.0	2.5	140.0	0.091	0.171	0.186	2.377
75	12	13	290.0	8.0	140.0	1.573	0.465	0.313	1.602
76	13	98	50.0	8.0	140.0	1.573	0.080	0.313	1.602
77	98	99	170.0	5.0	140.0	0.395	0.208	0.201	1.221
78	99	100	50.0	3.2	140.0	0.194	0.145	0.242	2.891
79	100	101	80.0	2.5	140.0	0.097	0.213	0.198	2.665
80	99	102	60.0	4.0	140.0	0.200	0.062	0.159	1.030
81	102	103	580.0	3.2	140.0	0.103	0.518	0.128	0.892
82	103	104	60.0	2.5	140.0	0.103	0.178	0.210	2.969
83	98	105	180.0	5.0	140.0	0.692	0.622	0.353	3.455
84	105	106	30.0	5.0	140.0	0.692	0.104	0.353	3.455
85	106	107	105.0	5.0	140.0	0.634	0.308	0.323	2.936
86	107	110	30.0	2.5	140.0	0.070	0.044	0.143	1.450
87	110	111	350.0	2.5	140.0	0.019	0.047	0.040	0.135
88	107	109	100.0	4.0	140.0	0.389	0.352	0.309	3.521
89	107	108	105.0	3.2	140.0	0.175	0.250	0.218	2.379
90	9	76	272.0	10.0	140.0	3.368	0.602	0.429	2.213
91	76	77	60.0	2.5	140.0	0.156	0.382	0.317	6.365
92	76	78	20.0	2.5	140.0	0.039	0.010	0.079	0.488
93	76	79	300.0	10.0	140.0	3.173	0.595	0.404	1.982
94	79	80	130.0	2.5	140.0	0.117	0.486	0.238	3.736
95	79	81	310.0	10.0	140.0	2.676	0.448	0.341	1.445
96	81	82	890.0	2.5	140.0	0.033	0.322	0.067	0.362
97	81	83	1000.0	10.0	140.0	2.643	1.412	0.336	1.412
98	83	84	78.0	4.0	140.0	0.467	0.385	0.371	4.935
99	83	85	70.0	2.5	140.0	0.097	0.187	0.198	2.665
100	83	86	195.0	10.0	140.0	2.079	0.177	0.265	0.905
101	86	87	80.0	2.5	140.0	0.049	0.059	0.099	0.738
102	86	88	540.0	10.0	140.0	2.030	0.468	0.258	0.867
103	88	89	90.0	4.0	140.0	0.486	0.479	0.387	5.323
104	88	90	270.0	8.0	140.0	1.495	0.394	0.297	1.458
105	90	91	40.0	2.5	140.0	0.194	0.385	0.396	9.621
106	90	92	60.0	8.0	140.0	1.301	0.068	0.259	1.127
107	92	93	220.0	10.0	140.0	1.204	0.072	0.153	0.329
108	93	94	90.0	5.0	140.0	0.523	0.185	0.266	2.056
109	93	95	300.0	8.0	140.0	0.681	0.102	0.135	0.339
110	95	96	60.0	6.5	140.0	0.681	0.056	0.205	0.933
111	15	16	40.0	2.5	140.0	0.389	1.389	0.792	34.733
112	15	17	60.0	2.5	140.0	0.321	1.459	0.654	24.322

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	44.407	29.440	14.97
2	0.00000	41.500	29.250	12.25
3	0.00000	41.404	29.370	12.03
4	0.00000	40.544	30.710	9.83
5	0.00000	40.342	30.430	9.91
6	0.68639	39.367	31.420	7.95
7	0.00000	38.913	31.420	7.49
8	0.00000	42.724	29.440	13.28
9	0.00000	41.633	30.440	11.19
10	0.00000	41.110	30.300	10.81
11	0.00000	40.701	30.180	10.52
12	0.00000	39.655	30.400	9.26
13	0.00000	39.191	30.600	8.59
14	0.35583	40.059	30.270	9.79
15	0.00000	38.973	30.530	8.44
16	0.38889	37.584	30.350	7.23
17	0.32083	37.514	30.220	7.29
18	0.00000	39.610	30.220	9.39
19	0.68056	38.139	30.220	7.92
20	0.68056	39.157	30.280	8.88
21	0.09722	39.024	30.300	8.72
22	0.29167	38.750	30.300	8.45
23	0.00000	38.511	30.100	8.41
24	0.58333	37.869	30.000	7.87
25	0.79917	37.175	30.100	7.07
26	0.19444	40.092	32.390	7.70
27	0.00000	40.264	30.130	10.13
28	0.19444	39.398	30.130	9.27
29	0.00000	40.119	30.130	9.99
30	0.19444	39.253	30.130	9.12
31	0.19444	39.923	30.130	9.79
32	0.48417	39.362	31.100	8.26
33	0.38889	38.888	30.000	8.89
34	0.09722	38.758	30.370	8.39

35	0.00000	38.987	31.130	7.85
36	0.11667	38.616	30.170	8.45
37	0.10889	38.548	31.260	7.29
38	0.00000	38.823	31.170	7.65
39	0.29167	38.645	31.000	7.65
40	0.09722	38.619	31.490	7.13
41	0.00000	38.630	31.490	7.14
42	0.09528	38.514	31.490	7.02
43	0.19444	38.733	31.490	7.24
44	0.19444	38.516	31.490	7.03
45	0.19444	38.662	31.490	7.17
46	0.09722	38.575	31.490	7.09
47	0.09722	38.551	31.490	7.06
48	0.00000	39.093	30.430	8.66
49	0.00000	39.017	30.520	8.50
50	0.00000	38.671	30.400	8.27
51	0.38889	38.044	30.570	7.47
52	0.00000	38.486	30.400	8.09
53	0.13611	38.387	30.430	7.96
54	0.38889	37.792	30.400	7.39
55	0.09722	38.844	30.520	8.32
56	0.09722	38.391	30.520	7.87
57	0.00000	39.924	29.040	10.88
58	0.00000	39.467	29.500	9.97
59	0.00000	39.079	29.450	9.63
60	0.38889	38.140	29.450	8.69
61	0.00000	39.086	29.600	9.49
62	0.64750	38.180	29.500	8.68
63	0.58333	37.759	29.500	8.26
64	0.09722	39.722	29.400	10.32
65	0.48611	36.571	29.500	7.07
66	0.09722	39.654	29.770	9.88
67	0.48611	38.234	29.770	8.46
68	0.00000	43.669	29.440	14.23
69	0.38889	40.641	29.660	10.98
70	0.97222	41.031	29.500	11.53
71	1.16083	39.444	29.500	9.94
72	0.97222	37.694	29.560	8.13
73	0.00000	39.642	30.600	9.04
74	0.58333	37.652	30.500	7.15
75	0.68056	36.664	28.590	8.07
76	0.00000	41.031	30.100	10.93
77	0.15556	40.649	29.800	10.85
78	0.03889	41.021	30.100	10.92
79	0.38111	40.436	29.500	10.94
80	0.11667	39.951	29.310	10.64
81	0.00000	39.989	29.430	10.56
82	0.03306	39.667	28.250	11.42
83	0.00000	38.576	30.040	8.54
84	0.46667	38.191	30.710	7.48
85	0.09722	38.390	29.850	8.54
86	0.00000	38.400	30.170	8.23
87	0.04861	38.341	30.040	8.30
88	0.04861	37.932	30.150	7.78
89	0.48611	37.453	30.200	7.25
90	0.00000	37.539	30.200	7.34
91	0.19444	37.153	30.100	7.05
92	0.09722	37.470	30.200	7.27
93	0.00000	37.399	30.300	7.10
94	0.52306	37.213	30.200	7.01
95	0.00000	37.296	30.300	7.00
96	0.68056	37.240	30.200	7.04
97	0.09139	39.484	30.630	8.85
98	0.48611	39.111	30.600	8.51
99	0.00000	38.903	30.470	8.43
100	0.09722	38.759	30.600	8.16
101	0.09722	38.545	30.600	7.95
102	0.09722	38.841	30.470	8.37
103	0.00000	38.324	30.770	7.55
104	0.10306	38.146	30.960	7.19
105	0.00000	38.489	30.890	7.60
106	0.05833	38.385	30.890	7.50
107	0.00000	38.077	30.700	7.38
108	0.17500	37.827	30.500	7.33
109	0.38889	37.725	30.690	7.03
110	0.05056	38.033	30.700	7.33
111	0.01944	37.986	30.690	7.30
112	0.00000	43.766	29.250	14.52

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	55.00	0.0	0.00
20.0	130.0	40.00	1910.0	76400.00
15.0	130.0	30.00	1067.0	32010.00

12.5	130.0	25.00	1131.0	28275.00
10.0	140.0	17.80	5241.0	93289.80
8.0	140.0	12.70	3972.0	50444.40
6.5	140.0	9.70	2480.0	24056.00
5.0	140.0	7.00	1697.0	11879.00
4.0	140.0	4.70	1743.0	8192.10
3.2	140.0	4.15	1992.0	8266.80
2.5	140.0	4.10	2742.0	11242.20
		TOTAL COST=		344055.30

SCHEME 2

KETEHRA,ZONE A,GROUP OF VILLAGES RURAL WATER SUPPLY SCHEME,ALLAHABAD

THIS SYSTEM HAS ONE OVER HEAD TANK

THIS SCHEME HAS 55 PIPES, 55 JUNCTIONS, 0 LOOP AND 1 FIXED GRADE NODE

THESE ARE THE RESULTS FOR THE FLOWS IN PIPES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	10.0	15.0	130.0	20.228	0.097	1.145	9.750	117.20
2	1	2	30.0	15.0	130.0	14.343	0.155	0.812	5.158	
3	2	3	350.0	10.0	140.0	5.117	1.681	0.652	4.802	
4	3	4	880.0	10.0	140.0	4.644	3.531	0.591	4.013	
5	4	5	570.0	6.5	140.0	1.513	2.337	0.456	4.099	
6	5	10	300.0	5.0	140.0	0.568	0.718	0.289	2.392	
7	4	11	400.0	3.2	140.0	0.284	2.329	0.353	5.822	
8	4	6	300.0	10.0	140.0	2.847	0.486	0.362	1.621	
9	6	7	600.0	10.0	140.0	0.946	0.126	0.120	0.211	
10	7	8	230.0	3.2	140.0	0.378	2.281	0.470	9.919	
11	2	13	1600.0	15.0	130.0	9.226	3.645	0.522	2.278	
12	13	14	360.0	8.0	140.0	2.960	1.860	0.589	5.167	
13	14	18	230.0	5.0	140.0	1.275	2.463	0.649	10.709	
14	18	19	100.0	2.5	140.0	0.284	1.937	0.578	19.374	
15	14	15	1065.0	8.0	140.0	1.496	1.555	0.298	1.460	
16	15	16	600.0	5.0	140.0	0.740	2.344	0.377	3.907	
17	16	17	120.0	2.5	140.0	0.170	0.903	0.347	7.522	
18	13	21	600.0	12.5	130.0	5.319	1.198	0.433	1.997	
19	21	22	350.0	4.0	140.0	0.757	4.228	0.602	12.080	
20	21	23	200.0	10.0	140.0	4.027	0.616	0.513	3.082	
21	23	24	90.0	5.0	140.0	0.946	0.554	0.482	6.160	
22	24	25	110.0	2.5	140.0	0.189	1.006	0.385	9.143	
23	24	26	310.0	4.0	140.0	0.662	2.924	0.527	9.433	
24	23	27	950.0	10.0	140.0	2.892	1.586	0.368	1.669	
25	27	28	300.0	4.0	140.0	0.420	1.218	0.334	4.060	
26	28	29	210.0	2.5	140.0	0.231	2.775	0.470	13.214	
27	27	30	750.0	6.5	140.0	0.950	1.297	0.286	1.729	
28	30	31	200.0	3.2	140.0	0.193	0.570	0.240	2.850	
29	30	32	250.0	6.5	140.0	0.662	0.222	0.200	0.887	
30	32	33	210.0	4.0	140.0	0.284	0.412	0.226	1.964	
31	32	34	300.0	4.0	140.0	0.284	0.589	0.226	1.964	
32	27	35	900.0	8.0	140.0	1.182	0.850	0.235	0.944	
33	35	36	400.0	4.0	140.0	0.388	1.401	0.309	3.503	
34	35	37	320.0	5.0	140.0	0.416	0.431	0.212	1.347	
35	37	38	200.0	4.0	140.0	0.265	0.346	0.211	1.728	
36	38	39	200.0	2.5	140.0	0.114	0.710	0.231	3.550	
37	1	40	600.0	12.5	130.0	5.885	1.445	0.480	2.408	
38	40	41	350.0	4.0	140.0	0.757	4.228	0.602	12.080	
39	41	42	80.0	2.5	140.0	0.284	1.550	0.578	19.374	
40	41	43	80.0	2.5	140.0	0.284	1.550	0.578	19.374	
41	40	44	500.0	12.5	130.0	5.128	0.933	0.418	1.866	
42	44	45	400.0	2.5	140.0	0.189	3.657	0.385	9.143	
43	44	46	400.0	8.0	140.0	2.088	1.083	0.415	2.708	
44	46	47	270.0	2.5	140.0	0.189	2.469	0.385	9.143	
45	46	48	700.0	8.0	140.0	1.805	1.446	0.359	2.066	
46	48	49	150.0	2.5	140.0	0.057	0.148	0.116	0.983	
47	48	50	100.0	2.5	140.0	0.038	0.046	0.077	0.464	
48	48	51	1500.0	8.0	140.0	1.667	2.674	0.332	1.783	
49	51	52	300.0	6.5	140.0	0.838	0.412	0.253	1.372	
50	44	53	1500.0	10.0	140.0	2.662	2.147	0.339	1.431	
51	53	54	330.0	4.0	140.0	0.568	2.340	0.452	7.090	
52	54	55	320.0	2.5	140.0	0.189	2.926	0.385	9.143	
53	53	9	800.0	8.0	140.0	1.905	1.827	0.379	2.284	
54	9	20	300.0	5.0	140.0	0.946	1.848	0.482	6.160	
55	3	12	400.0	3.2	140.0	0.189	1.099	0.235	2.748	

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	117.103	100.030	17.07
2	0.00000	116.948	99.620	17.33
3	0.28375	115.267	99.310	15.96
4	0.00000	111.736	99.790	11.95
5	0.94583	109.399	99.530	9.87
6	1.90112	111.249	99.910	11.34

7	0.56750	111.123	99.900	11.22
8	0.37833	108.842	99.890	8.95
9	0.95907	110.751	99.300	11.45
10	0.56750	108.682	99.530	9.15
11	0.28375	109.407	99.880	9.53
12	0.18917	114.168	100.150	14.02
13	0.94583	113.303	99.200	14.10
14	0.18917	111.443	99.980	11.46
15	0.75667	109.887	99.110	10.78
16	0.56939	107.544	99.240	8.30
17	0.17025	106.641	99.320	7.32
18	0.99123	108.980	99.490	9.49
19	0.28375	107.042	99.530	7.51
20	0.94583	108.903	99.430	9.47
21	0.53534	112.105	99.300	12.80
22	0.75667	107.877	99.200	8.68
23	0.18917	111.489	99.390	12.10
24	0.09458	110.934	98.600	12.33
25	0.18917	109.928	99.140	10.79
26	0.66208	108.010	98.680	9.33
27	0.34050	109.902	99.080	10.82
28	0.18917	108.685	98.600	10.08
29	0.23078	105.910	98.920	6.99
30	0.09458	108.606	99.000	9.61
31	0.19295	108.035	99.350	8.69
32	0.09458	108.384	99.230	9.15
33	0.28375	107.971	99.410	8.56
34	0.28375	107.795	99.310	8.48
35	0.37833	109.053	99.130	9.92
36	0.38779	107.652	99.010	8.64
37	0.15133	108.622	99.180	9.44
38	0.15133	108.276	99.230	9.05
39	0.11350	107.566	99.510	8.06
40	0.00000	115.658	98.980	16.68
41	0.18917	111.430	97.710	13.72
42	0.28375	109.880	99.480	10.40
43	0.28375	109.880	99.520	10.36
44	0.18917	114.725	98.600	16.13
45	0.18917	111.068	99.150	11.92
46	0.09458	113.642	99.630	14.01
47	0.18917	111.173	99.820	11.35
48	0.04351	112.196	100.280	11.92
49	0.05675	112.048	100.530	11.52
50	0.03783	112.149	100.610	11.54
51	0.82855	109.522	100.220	9.30
52	0.83801	109.110	99.960	9.15
53	0.18917	112.578	99.010	13.57
54	0.37833	110.238	99.190	11.05
55	0.18917	107.313	99.320	7.99

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	55.00	0.0	0.00
20.0	130.0	40.00	0.0	0.00
15.0	130.0	30.00	1640.0	49200.00
12.5	130.0	25.00	1700.0	42500.00
10.0	140.0	18.85	4780.0	90103.00
8.0	140.0	12.70	5725.0	72707.50
6.5	140.0	9.70	1870.0	18139.00
5.0	140.0	7.00	1840.0	12880.00
4.0	140.0	4.70	2750.0	12925.00
3.2	140.0	4.15	1230.0	5104.50
2.5	140.0	4.10	2140.0	8774.00
	TOTAL COST=			312333.00

THE FOLLOWING CHANGES IN SYSTEM DATA ARE MADE

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS
6	5	10	300.0	4.0	140.0
55	3	12	400.0	2.5	140.0
31	32	34	300.0	3.2	140.0
28	30	31	200.0	2.5	140.0
30	32	33	210.0	3.2	140.0

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	10.0	15.0	130.0	20.228	0.097	1.145	9.750	117.20
2	1	2	30.0	15.0	130.0	14.343	0.155	0.812	5.158	
3	2	3	350.0	10.0	140.0	5.117	1.681	0.652	4.802	
4	3	4	880.0	10.0	140.0	4.644	3.531	0.591	4.013	
5	4	5	570.0	6.5	140.0	1.513	2.337	0.456	4.099	
6	5	10	300.0	4.0	140.0	0.568	2.127	0.452	7.090	
7	4	11	400.0	3.2	140.0	0.284	2.329	0.353	5.822	
8	4	6	300.0	10.0	140.0	2.847	0.486	0.362	1.621	
9	6	7	600.0	10.0	140.0	0.946	0.126	0.120	0.211	
10	7	8	230.0	3.2	140.0	0.378	2.281	0.470	9.919	
11	2	13	1600.0	15.0	130.0	9.226	3.645	0.522	2.278	
12	13	14	360.0	8.0	140.0	2.960	1.860	0.589	5.167	
13	14	18	230.0	5.0	140.0	1.275	2.463	0.649	10.709	
14	18	19	100.0	2.5	140.0	0.284	1.937	0.578	19.374	
15	14	15	1065.0	8.0	140.0	1.496	1.555	0.298	1.460	
16	15	16	600.0	5.0	140.0	0.740	2.344	0.377	3.907	
17	16	17	120.0	2.5	140.0	0.170	0.903	0.347	7.522	
18	13	21	600.0	12.5	130.0	5.319	1.198	0.433	1.997	
19	21	22	350.0	4.0	140.0	0.757	4.228	0.602	12.080	
20	21	23	200.0	10.0	140.0	4.027	0.616	0.513	3.082	
21	23	24	90.0	5.0	140.0	0.946	0.554	0.482	6.160	
22	24	25	110.0	2.5	140.0	0.189	1.006	0.385	9.143	
23	24	26	310.0	4.0	140.0	0.662	2.924	0.527	9.433	
24	23	27	950.0	10.0	140.0	2.892	1.586	0.368	1.669	
25	27	28	300.0	4.0	140.0	0.420	1.218	0.334	4.060	
26	28	29	210.0	2.5	140.0	0.231	2.775	0.470	13.214	
27	27	30	750.0	6.5	140.0	0.950	1.297	0.286	1.729	
28	30	31	200.0	2.5	140.0	0.193	1.897	0.393	9.485	
29	30	32	250.0	6.5	140.0	0.662	0.222	0.200	0.887	
30	32	33	210.0	3.2	140.0	0.284	1.223	0.353	5.822	
31	32	34	300.0	3.2	140.0	0.284	1.747	0.353	5.822	
32	27	35	900.0	8.0	140.0	1.182	0.850	0.235	0.944	
33	35	36	400.0	4.0	140.0	0.388	1.401	0.309	3.503	
34	35	37	320.0	5.0	140.0	0.416	0.431	0.212	1.347	
35	37	38	200.0	4.0	140.0	0.265	0.346	0.211	1.728	
36	38	39	200.0	2.5	140.0	0.114	0.710	0.231	3.550	
37	1	40	600.0	12.5	130.0	5.885	1.445	0.480	2.408	
38	40	41	350.0	4.0	140.0	0.757	4.228	0.602	12.080	
39	41	42	80.0	2.5	140.0	0.284	1.550	0.578	19.374	
40	41	43	80.0	2.5	140.0	0.284	1.550	0.578	19.374	
41	40	44	500.0	12.5	130.0	5.128	0.933	0.418	1.866	
42	44	45	400.0	2.5	140.0	0.189	3.657	0.385	9.143	
43	44	46	400.0	8.0	140.0	2.088	1.083	0.415	2.708	
44	46	47	270.0	2.5	140.0	0.189	2.469	0.385	9.143	
45	46	48	700.0	8.0	140.0	1.805	1.446	0.359	2.066	
46	48	49	150.0	2.5	140.0	0.057	0.148	0.116	0.983	
47	48	50	100.0	2.5	140.0	0.038	0.046	0.077	0.464	
48	48	51	1500.0	8.0	140.0	1.667	2.674	0.332	1.783	
49	51	52	300.0	6.5	140.0	0.838	0.412	0.253	1.372	
50	44	53	1500.0	10.0	140.0	2.662	2.147	0.339	1.431	
51	53	54	330.0	4.0	140.0	0.568	2.340	0.452	7.090	
52	54	55	320.0	2.5	140.0	0.189	2.926	0.385	9.143	
53	53	9	800.0	8.0	140.0	1.905	1.827	0.379	2.284	
54	9	20	300.0	5.0	140.0	0.946	1.848	0.482	6.160	
55	3	12	400.0	2.5	140.0	0.189	3.657	0.385	9.143	

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	117.103	100.030	17.07
2	0.00000	116.948	99.620	17.33
3	0.28375	115.267	99.310	15.96
4	0.00000	111.736	99.790	11.95
5	0.94583	109.399	99.530	9.87
6	1.90112	111.249	99.910	11.34
7	0.56750	111.123	99.900	11.22
8	0.37833	108.842	99.890	8.95

SCHEME 3

URWA,PART II,GROUP OF VILLAGES RURAL WATER SUPPLY SCHEME,ALLAHABAD

THIS SYSTEM HAS ONE OVER HEAD TANK

THIS SCHEME HAS 138 PIPES, 138 JUNCTIONS, 0 LOOP AND 1 FIXED GRADE NODE

THESE ARE THE RESULTS FOR THE FLOWS IN PIPES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	100.0	25.0	130.0	61.912	0.643	1.261	6.432	114.00
2	1	2	340.0	4.0	140.0	0.625	2.882	0.497	8.478	
3	1	3	750.0	25.0	130.0	26.526	1.004	0.540	1.338	
4	3	5	140.0	20.0	130.0	16.531	0.231	0.526	1.653	
5	5	4	80.0	3.2	140.0	0.644	2.123	0.800	26.535	
6	5	6	150.0	3.2	140.0	0.486	2.367	0.604	15.779	
7	5	7	900.0	20.0	130.0	15.402	1.305	0.490	1.450	
8	7	8	100.0	2.5	140.0	0.125	0.424	0.255	4.245	
9	7	9	200.0	20.0	130.0	15.160	0.282	0.483	1.408	
10	9	10	70.0	4.0	140.0	0.500	0.393	0.398	5.608	
11	10	11	450.0	3.2	140.0	0.375	4.391	0.466	9.758	
12	9	12	615.0	20.0	130.0	14.410	0.788	0.459	1.282	
13	12	13	525.0	5.0	140.0	0.972	3.403	0.495	6.482	
14	12	14	650.0	20.0	130.0	12.868	0.676	0.410	1.039	
15	14	15	390.0	5.0	140.0	1.021	2.767	0.520	7.096	
16	15	16	140.0	4.0	140.0	0.389	0.493	0.309	3.521	
17	15	17	100.0	4.0	140.0	0.389	0.352	0.309	3.521	
18	14	18	1400.0	20.0	130.0	11.138	1.114	0.355	0.795	
19	18	19	50.0	6.5	140.0	2.625	0.568	0.791	11.367	
20	19	20	140.0	4.0	140.0	0.583	1.044	0.464	7.460	
21	19	21	270.0	6.5	140.0	2.042	1.927	0.615	7.137	
22	21	22	250.0	5.0	140.0	0.972	1.620	0.495	6.482	
23	21	23	145.0	3.2	140.0	0.486	2.288	0.604	15.779	
24	18	24	120.0	4.0	140.0	0.875	1.898	0.696	15.813	
25	24	25	90.0	3.2	140.0	0.243	0.394	0.302	4.373	
26	24	26	130.0	2.5	140.0	0.243	1.891	0.495	14.550	
27	18	27	270.0	15.0	140.0	7.638	0.378	0.432	1.400	
28	27	28	200.0	2.5	140.0	0.194	1.923	0.396	9.617	
29	27	29	220.0	15.0	140.0	7.443	0.294	0.421	1.334	
30	29	30	210.0	3.2	140.0	0.292	1.287	0.363	6.128	
31	29	31	70.0	12.5	140.0	7.152	0.211	0.583	3.011	
32	31	32	180.0	3.2	140.0	0.292	1.103	0.363	6.128	
33	31	33	815.0	12.5	140.0	6.860	2.272	0.559	2.788	
34	33	34	810.0	12.5	140.0	2.611	0.378	0.213	0.466	
35	34	35	90.0	10.0	140.0	1.750	0.059	0.223	0.658	
36	35	36	155.0	6.5	140.0	0.778	0.185	0.234	1.195	
37	34	37	100.0	6.5	140.0	0.340	0.026	0.103	0.259	
38	35	38	980.0	8.0	140.0	0.972	0.644	0.193	0.657	
39	33	39	290.0	8.0	140.0	1.604	0.482	0.319	1.661	
40	39	40	180.0	4.0	140.0	0.243	0.265	0.193	1.474	
41	39	41	650.0	8.0	140.0	0.778	0.283	0.155	0.435	
42	33	42	590.0	12.5	140.0	2.644	0.281	0.215	0.477	
43	42	43	190.0	8.0	140.0	0.972	0.125	0.193	0.657	
44	42	44	160.0	10.0	140.0	1.283	0.059	0.163	0.371	
45	44	45	210.0	3.2	140.0	0.117	0.236	0.145	1.123	
46	44	46	475.0	5.0	140.0	0.583	1.195	0.297	2.516	
47	3	47	900.0	20.0	130.0	9.994	0.586	0.318	0.651	
48	47	48	90.0	3.2	140.0	0.249	0.411	0.309	4.568	
49	47	49	266.0	5.0	140.0	0.780	1.146	0.397	4.307	
50	49	50	90.0	3.2	140.0	0.194	0.260	0.242	2.890	
51	49	51	220.0	4.0	140.0	0.486	1.171	0.387	5.323	
52	47	52	440.0	15.0	140.0	8.966	0.829	0.507	1.884	
53	52	53	625.0	6.5	140.0	1.750	3.353	0.527	5.365	
54	52	54	210.0	12.5	140.0	7.216	0.643	0.588	3.062	
55	54	55	330.0	4.0	140.0	0.714	3.576	0.568	10.837	
56	54	56	280.0	12.5	140.0	6.502	0.707	0.530	2.525	
57	56	57	225.0	6.5	140.0	1.070	0.485	0.322	2.155	
58	57	58	220.0	3.2	140.0	0.389	2.297	0.484	10.439	
59	57	59	210.0	3.2	140.0	0.389	2.192	0.484	10.439	
60	56	60	460.0	12.5	140.0	5.433	0.833	0.443	1.810	
61	60	61	135.0	3.2	140.0	0.389	1.409	0.484	10.439	
62	60	62	120.0	10.0	140.0	5.044	0.561	0.642	4.676	
63	62	63	250.0	8.0	140.0	2.127	0.700	0.423	2.801	
64	63	64	495.0	4.0	140.0	0.292	1.023	0.232	2.067	
65	63	65	560.0	6.5	140.0	1.392	1.967	0.420	3.512	
66	65	66	510.0	6.5	140.0	1.392	1.791	0.420	3.512	
67	62	67	270.0	10.0	140.0	2.917	0.458	0.371	1.696	
68	57	68	375.0	4.0	140.0	0.389	1.320	0.309	3.521	

69	68	69	200.0	5.0	140.0	0.389	0.238	0.198	1.188
70	67	70	480.0	10.0	140.0	2.528	0.624	0.322	1.301
71	70	71	400.0	5.0	140.0	0.583	1.007	0.297	2.516
72	1	72	60.0	20.0	130.0	13.177	0.065	0.419	1.086
73	72	73	310.0	8.0	140.0	2.333	1.031	0.464	3.325
74	73	74	645.0	5.0	140.0	1.167	5.860	0.594	9.086
75	73	75	1475.0	6.5	140.0	1.167	3.735	0.352	2.532
76	1	76	1200.0	20.0	130.0	21.584	3.250	0.687	2.709
77	76	77	200.0	10.0	140.0	8.037	2.216	1.023	11.082
78	77	78	150.0	8.0	140.0	7.787	4.648	1.549	30.984
79	78	79	625.0	6.5	140.0	1.500	2.520	0.452	4.033
80	77	80	120.0	2.5	140.0	0.250	1.839	0.509	15.324
81	78	82	160.0	8.0	140.0	6.287	3.336	1.251	20.847
82	82	83	220.0	4.0	140.0	0.625	1.865	0.497	8.479
83	82	84	450.0	8.0	140.0	5.662	7.728	1.126	17.172
84	84	88	120.0	6.5	140.0	2.375	1.133	0.716	9.445
85	88	85	90.0	4.0	140.0	1.000	1.822	0.796	20.245
86	88	89	620.0	6.5	140.0	1.375	2.128	0.414	3.432
87	84	87	160.0	8.0	140.0	2.037	0.414	0.405	2.586
88	87	86	320.0	4.0	140.0	0.500	1.795	0.398	5.609
89	87	90	75.0	8.0	140.0	1.537	0.115	0.306	1.535
90	90	91	90.0	2.5	140.0	0.250	1.379	0.509	15.324
91	90	92	2450.0	8.0	140.0	1.287	2.707	0.256	1.105
92	76	93	1210.0	20.0	130.0	13.546	1.383	0.431	1.143
93	93	94	560.0	4.0	140.0	0.500	3.140	0.398	5.608
94	93	95	190.0	20.0	130.0	13.046	0.203	0.415	1.066
95	95	96	275.0	8.0	140.0	2.000	0.687	0.398	2.499
96	96	97	310.0	4.0	140.0	0.750	3.684	0.597	11.883
97	96	98	1220.0	8.0	140.0	1.250	1.277	0.249	1.047
98	95	99	1110.0	20.0	130.0	11.046	0.870	0.352	0.783
99	99	100	275.0	6.5	140.0	1.229	0.767	0.370	2.788
100	100	101	190.0	5.0	140.0	0.778	0.815	0.396	4.288
101	100	102	150.0	4.0	140.0	0.257	0.245	0.204	1.631
102	99	103	50.0	15.0	140.0	9.818	0.111	0.556	2.228
103	103	104	750.0	8.0	140.0	2.139	2.123	0.426	2.830
104	103	105	940.0	15.0	140.0	7.679	1.329	0.435	1.414
105	105	106	400.0	6.5	140.0	1.167	1.013	0.352	2.532
106	105	107	400.0	10.0	140.0	4.373	1.436	0.557	3.590
107	107	108	330.0	8.0	140.0	1.643	0.573	0.327	1.736
108	108	109	980.0	6.5	140.0	0.962	1.738	0.290	1.773
109	108	110	90.0	4.0	140.0	0.194	0.088	0.155	0.975
110	107	111	800.0	6.5	140.0	0.980	1.467	0.295	1.833
111	72	112	950.0	15.0	140.0	10.844	2.545	0.614	2.679
112	112	113	300.0	6.5	140.0	1.365	1.016	0.411	3.386
113	113	114	115.0	3.2	140.0	0.393	1.223	0.488	10.632
114	113	115	220.0	4.0	140.0	0.778	2.797	0.619	12.712
115	112	116	485.0	12.5	140.0	9.479	2.461	0.772	5.074
116	116	117	150.0	8.0	140.0	2.442	0.543	0.486	3.618
117	117	118	460.0	5.0	140.0	0.420	0.630	0.214	1.370
118	117	119	150.0	3.2	140.0	0.272	0.809	0.338	5.391
119	117	120	580.0	8.0	140.0	1.750	1.132	0.348	1.952
120	116	131	340.0	12.5	140.0	3.877	0.329	0.316	0.969
121	131	132	140.0	2.5	140.0	0.177	1.131	0.360	8.076
122	131	133	650.0	12.5	140.0	3.016	0.396	0.246	0.609
123	133	134	1100.0	12.5	140.0	3.016	0.669	0.246	0.609
124	134	135	230.0	8.0	140.0	1.071	0.181	0.213	0.787
125	135	136	70.0	3.2	140.0	0.099	0.058	0.123	0.831
126	135	137	120.0	4.0	140.0	0.389	0.423	0.309	3.521
127	134	138	680.0	8.0	140.0	1.556	1.067	0.309	1.569
128	131	81	1800.0	6.5	140.0	0.684	1.697	0.206	0.943
129	115	121	255.0	10.0	140.0	3.160	0.501	0.402	1.966
130	121	122	120.0	3.2	140.0	0.389	1.253	0.484	10.439
131	121	123	600.0	10.0	140.0	2.771	0.925	0.353	1.542
132	123	124	310.0	3.2	140.0	0.194	0.896	0.242	2.890
133	123	125	1100.0	10.0	140.0	2.576	1.482	0.328	1.348
134	125	126	530.0	8.0	140.0	1.604	0.880	0.319	1.661
135	126	127	155.0	5.0	140.0	0.292	0.108	0.149	0.697
136	126	128	100.0	4.0	140.0	0.146	0.057	0.116	0.572
137	125	129	250.0	4.0	140.0	0.389	0.880	0.309	3.521
138	125	130	270.0	5.0	140.0	0.486	0.485	0.248	1.795

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	113.357	100.200	13.16
2	0.62500	110.474	99.870	10.60
3	0.00000	112.353	100.410	11.94
4	0.64360	109.999	100.180	9.82
5	0.00000	112.122	100.240	11.88
6	0.48610	109.755	99.870	9.88
7	0.11670	110.817	99.430	11.39
8	0.12500	110.392	99.400	10.99
9	0.25000	110.535	99.100	11.44
10	0.12500	110.143	98.830	11.31
11	0.37500	105.751	98.760	6.99
12	0.56940	109.747	98.600	11.15

13	0.97220	106.344	98.500	7.84
14	0.70970	109.071	98.400	10.67
15	0.24310	106.304	98.300	8.00
16	0.38890	105.811	98.180	7.63
17	0.38890	105.952	98.200	7.75
18	0.00000	107.958	97.220	10.74
19	0.00000	107.389	95.780	11.61
20	0.58330	106.345	95.600	10.74
21	0.58330	105.462	95.700	9.76
22	0.97220	103.842	94.980	8.86
23	0.48610	103.174	95.680	7.49
24	0.38890	106.060	96.000	10.06
25	0.24310	105.667	96.200	9.47
26	0.24310	104.169	96.400	7.77
27	0.00000	107.580	96.700	10.88
28	0.19440	105.656	97.830	7.83
29	0.00000	107.286	97.000	10.29
30	0.29170	105.999	96.800	9.20
31	0.00000	107.075	96.900	10.18
32	0.29170	105.972	96.720	9.25
33	0.00000	104.803	97.610	7.19
34	0.52110	104.426	97.400	7.03
35	0.00000	104.367	97.320	7.05
36	0.77780	104.181	97.230	6.95
37	0.34030	104.400	97.620	6.78
38	0.97220	103.723	96.970	6.75
39	0.58330	104.322	97.510	6.81
40	0.24305	104.056	97.480	6.58
41	0.77780	104.039	96.700	7.34
42	0.38890	104.522	97.520	7.00
43	0.97220	104.397	97.480	6.92
44	0.58330	104.463	97.480	6.98
45	0.11670	104.227	97.300	6.93
46	0.58330	103.267	96.420	6.85
47	0.00000	111.767	100.360	11.41
48	0.24890	111.356	100.100	11.26
49	0.09916	110.621	100.260	10.36
50	0.19440	110.361	99.820	10.54
51	0.48610	109.451	99.730	9.72
52	0.00000	110.938	100.210	10.73
53	1.75000	107.585	99.710	7.88
54	0.00000	110.295	99.870	10.43
55	0.71360	106.719	99.800	6.92
56	0.00000	109.589	99.730	9.86
57	0.29170	109.104	99.640	9.46
58	0.38890	106.807	99.810	7.00
59	0.38890	106.912	99.450	7.46
60	0.00000	108.756	99.520	9.24
61	0.38890	107.347	99.000	8.35
62	0.00000	108.195	99.500	8.69
63	0.44330	107.495	99.690	7.80
64	0.29167	106.472	98.520	7.95
65	0.00000	105.528	99.500	6.03
66	1.39220	103.736	99.480	4.26
67	0.00000	107.737	99.400	8.34
68	0.00000	106.417	98.860	7.56
69	0.38890	106.179	98.780	7.40
70	1.94440	107.113	98.600	8.51
71	0.58330	106.106	98.420	7.69
72	0.00000	113.292	99.970	13.32
73	0.00000	112.261	99.670	12.59
74	1.16670	106.400	98.020	8.38
75	1.16670	108.526	99.500	9.03
76	0.00000	110.107	99.800	10.31
77	0.00000	107.890	99.700	8.19
78	0.00000	103.243	99.600	3.64
79	1.50000	100.722	99.430	1.29
80	0.25000	106.051	99.830	6.22
81	0.68440	106.259	98.530	7.73
82	0.00000	99.907	99.500	0.41
83	0.62500	98.042	99.530	-1.49
84	1.25000	92.180	99.760	-7.58
85	1.00000	89.224	98.400	-9.18
86	0.50000	89.971	99.300	-9.33
87	0.00000	91.766	99.640	-7.87
88	0.00000	91.046	98.530	-7.48
89	1.37500	88.918	98.450	-9.53
90	0.00000	91.651	99.000	-7.35
91	0.25000	90.272	98.930	-8.66
92	1.28720	88.943	97.760	-8.82
93	0.00000	108.723	99.000	9.72
94	0.50000	105.583	98.860	6.72
95	0.00000	108.521	99.000	9.52
96	0.00000	107.834	98.650	9.18
97	0.75000	104.150	97.830	6.32
98	1.25000	106.557	98.580	7.98
99	0.00000	107.651	98.730	8.92
100	0.19440	106.885	98.610	8.27
101	0.77780	106.070	98.550	7.52

102	0.25670	106.640	98.570	8.07
103	0.00000	107.540	98.750	8.79
104	2.13890	105.417	97.600	7.82
105	2.13890	106.211	98.460	7.75
106	1.16670	105.198	97.950	7.25
107	1.75000	104.775	97.830	6.95
108	0.48610	104.202	97.500	6.70
109	0.96250	102.465	97.000	5.46
110	0.19440	104.114	97.430	6.68
111	0.98000	103.309	96.330	6.98
112	0.00000	110.747	100.300	10.45
113	0.19440	109.731	99.800	9.93
114	0.39278	108.508	98.600	9.91
115	0.77780	106.934	98.450	8.48
116	0.00000	108.286	100.360	7.93
117	0.00000	107.743	100.390	7.35
118	0.42000	107.113	99.720	7.39
119	0.27220	106.934	99.910	7.02
120	1.75000	106.611	99.870	6.74
121	0.00000	107.784	99.730	8.05
122	0.38890	106.532	99.820	6.71
123	0.00000	106.859	98.400	8.46
124	0.19440	105.963	98.000	7.96
125	0.09720	105.377	97.700	7.68
126	1.16670	104.496	97.870	6.63
127	0.29167	104.388	97.800	6.59
128	0.14580	104.439	97.600	6.84
129	0.38890	104.497	97.480	7.02
130	0.48610	104.892	97.600	7.29
131	0.00000	107.956	99.730	8.23
132	0.17690	106.826	98.760	8.07
133	0.00000	107.561	98.970	8.59
134	0.38890	106.891	98.900	7.99
135	0.58330	106.710	99.000	7.71
136	0.09917	106.652	98.800	7.85
137	0.38890	106.288	98.560	7.73
138	1.55560	105.824	97.800	8.02

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	112.00	850.0	95200.00
20.0	130.0	83.00	8575.0	711725.00
15.0	140.0	41.80	2870.0	119966.00
12.5	140.0	31.50	5810.0	183015.00
10.0	140.0	19.20	3675.0	70560.00
8.0	140.0	13.80	10860.0	149868.00
6.5	140.0	9.60	9890.0	94944.00
5.0	140.0	6.90	4226.0	29159.40
4.0	140.0	6.20	4940.0	30628.00
3.2	140.0	4.10	3025.0	12402.50
2.5	140.0	4.00	780.0	3120.00
		TOTAL COST=		1500587.90

THE FOLLOWING CHANGES IN SYSTEM DATA ARE MADE

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS
66	65	66	570.0	8.0	140.0
77	76	77	200.0	12.5	140.0
78	77	78	150.0	12.5	140.0
81	78	82	160.0	12.5	140.0
83	82	84	450.0	12.5	140.0
87	84	87	160.0	12.5	140.0
89	87	90	75.0	12.5	140.0
108	108	109	980.0	8.0	140.0
16	15	16	140.0	3.2	140.0
17	15	17	100.0	3.2	140.0
20	19	20	140.0	3.2	140.0
41	39	41	650.0	6.5	140.0
51	49	51	220.0	3.2	140.0
127	134	138	680.0	6.5	140.0
101	100	102	150.0	3.2	140.0
65	63	65	560.0	8.0	140.0
86	88	89	620.0	8.0	140.0

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	100.0	25.0	130.0	61.912	0.643	1.261	6.432	114.00
2	1	2	340.0	4.0	140.0	0.625	2.882	0.497	8.478	
3	1	3	750.0	25.0	130.0	26.526	1.004	0.540	1.338	
4	3	5	140.0	20.0	130.0	16.531	0.231	0.526	1.653	
5	5	4	80.0	3.2	140.0	0.644	2.123	0.800	26.535	
6	5	6	150.0	3.2	140.0	0.486	2.367	0.604	15.779	
7	5	7	900.0	20.0	130.0	15.402	1.305	0.490	1.450	
8	7	8	100.0	2.5	140.0	0.125	0.424	0.255	4.245	
9	7	9	200.0	20.0	130.0	15.160	0.282	0.483	1.408	
10	9	10	70.0	4.0	140.0	0.500	0.393	0.398	5.608	
11	10	11	450.0	3.2	140.0	0.375	4.391	0.466	9.758	
12	9	12	615.0	20.0	130.0	14.410	0.788	0.459	1.282	
13	12	13	525.0	5.0	140.0	0.972	3.403	0.495	6.482	
14	12	14	650.0	20.0	130.0	12.868	0.676	0.410	1.039	
15	14	15	390.0	5.0	140.0	1.021	2.767	0.520	7.096	
16	15	16	140.0	3.2	140.0	0.389	1.461	0.484	10.439	
17	15	17	100.0	3.2	140.0	0.389	1.044	0.484	10.439	
18	14	18	1400.0	20.0	130.0	11.138	1.114	0.355	0.795	
19	18	19	50.0	6.5	140.0	2.625	0.568	0.791	11.367	
20	19	20	140.0	3.2	140.0	0.583	3.096	0.725	22.116	
21	19	21	270.0	6.5	140.0	2.042	1.927	0.615	7.137	
22	21	22	250.0	5.0	140.0	0.972	1.620	0.495	6.482	
23	21	23	145.0	3.2	140.0	0.486	2.288	0.604	15.779	
24	18	24	120.0	4.0	140.0	0.875	1.898	0.696	15.813	
25	24	25	90.0	3.2	140.0	0.243	0.394	0.302	4.373	
26	24	26	130.0	2.5	140.0	0.243	1.891	0.495	14.550	
27	18	27	270.0	15.0	140.0	7.638	0.378	0.432	1.400	
28	27	28	200.0	2.5	140.0	0.194	1.923	0.396	9.617	
29	27	29	220.0	15.0	140.0	7.443	0.294	0.421	1.334	
30	29	30	210.0	3.2	140.0	0.292	1.287	0.363	6.128	
31	29	31	70.0	12.5	140.0	7.152	0.211	0.583	3.011	
32	31	32	180.0	3.2	140.0	0.292	1.103	0.363	6.128	
33	31	33	815.0	12.5	140.0	6.860	2.272	0.559	2.788	
34	33	34	810.0	12.5	140.0	2.611	0.378	0.213	0.466	
35	34	35	90.0	10.0	140.0	1.750	0.059	0.223	0.658	
36	35	36	155.0	6.5	140.0	0.778	0.185	0.234	1.195	
37	34	37	100.0	6.5	140.0	0.340	0.026	0.103	0.259	
38	35	38	980.0	8.0	140.0	0.972	0.644	0.193	0.657	
39	33	39	290.0	8.0	140.0	1.604	0.482	0.319	1.661	
40	39	40	180.0	4.0	140.0	0.243	0.265	0.193	1.474	
41	39	41	650.0	6.5	140.0	0.778	0.777	0.234	1.195	
42	33	42	590.0	12.5	140.0	2.644	0.281	0.215	0.477	
43	42	43	190.0	8.0	140.0	0.972	0.125	0.193	0.657	
44	42	44	160.0	10.0	140.0	1.283	0.059	0.163	0.371	
45	44	45	210.0	3.2	140.0	0.117	0.236	0.145	1.123	
46	44	46	475.0	5.0	140.0	0.583	1.195	0.297	2.516	
47	3	47	900.0	20.0	130.0	9.994	0.586	0.318	0.651	
48	47	48	90.0	3.2	140.0	0.249	0.411	0.309	4.568	
49	47	49	266.0	5.0	140.0	0.780	1.146	0.397	4.307	
50	49	50	90.0	3.2	140.0	0.194	0.260	0.242	2.890	
51	49	51	220.0	3.2	140.0	0.486	3.471	0.604	15.779	
52	47	52	440.0	15.0	140.0	8.966	0.829	0.507	1.884	
53	52	53	625.0	6.5	140.0	1.750	3.353	0.527	5.365	
54	52	54	210.0	12.5	140.0	7.216	0.643	0.588	3.062	
55	54	55	330.0	4.0	140.0	0.714	3.576	0.568	10.837	
56	54	56	280.0	12.5	140.0	6.502	0.707	0.530	2.525	
57	56	57	225.0	6.5	140.0	1.070	0.485	0.322	2.155	
58	57	58	220.0	3.2	140.0	0.389	2.297	0.484	10.439	

59	57	59	210.0	3.2	140.0	0.389	2.192	0.484	10.439
60	56	60	460.0	12.5	140.0	5.433	0.833	0.443	1.810
61	60	61	135.0	3.2	140.0	0.389	1.409	0.484	10.439
62	60	62	120.0	10.0	140.0	5.044	0.561	0.642	4.676
63	62	63	250.0	8.0	140.0	2.127	0.700	0.423	2.801
64	63	64	495.0	4.0	140.0	0.292	1.023	0.232	2.067
65	63	65	560.0	8.0	140.0	1.392	0.716	0.277	1.278
66	65	66	570.0	8.0	140.0	1.392	0.728	0.277	1.278
67	62	67	270.0	10.0	140.0	2.917	0.458	0.371	1.696
68	67	68	375.0	4.0	140.0	0.389	1.320	0.309	3.521
69	68	69	200.0	5.0	140.0	0.389	0.238	0.198	1.188
70	67	70	480.0	10.0	140.0	2.528	0.624	0.322	1.301
71	70	71	400.0	5.0	140.0	0.583	1.007	0.297	2.516
72	1	72	60.0	20.0	130.0	13.177	0.065	0.419	1.086
73	72	73	310.0	8.0	140.0	2.333	1.031	0.464	3.325
74	73	74	645.0	5.0	140.0	1.167	5.860	0.594	9.086
75	73	75	1475.0	6.5	140.0	1.167	3.735	0.352	2.532
76	1	76	1200.0	20.0	130.0	21.584	3.250	0.687	2.709
77	76	77	200.0	12.5	140.0	8.037	0.748	0.655	3.738
78	77	78	150.0	12.5	140.0	7.787	0.529	0.635	3.526
79	78	79	625.0	6.5	140.0	1.500	2.520	0.452	4.033
80	77	80	120.0	2.5	140.0	0.250	1.839	0.509	15.324
81	78	82	160.0	12.5	140.0	6.287	0.380	0.512	2.372
82	82	83	220.0	4.0	140.0	0.625	1.865	0.497	8.478
83	82	84	450.0	12.5	140.0	5.662	0.879	0.461	1.954
84	84	88	120.0	6.5	140.0	2.375	1.133	0.716	9.445
85	88	85	90.0	4.0	140.0	1.000	1.822	0.796	20.245
86	88	89	620.0	8.0	140.0	1.375	0.774	0.274	1.249
87	84	87	160.0	12.5	140.0	2.037	0.047	0.166	0.294
88	87	86	320.0	4.0	140.0	0.500	1.795	0.398	5.608
89	87	90	75.0	12.5	140.0	1.537	0.013	0.125	0.175
90	90	91	90.0	2.5	140.0	0.250	1.379	0.509	15.324
91	90	92	2450.0	8.0	140.0	1.287	2.707	0.256	1.105
92	76	93	1210.0	20.0	130.0	13.546	1.383	0.431	1.143
93	93	94	560.0	4.0	140.0	0.500	3.140	0.398	5.608
94	93	95	190.0	20.0	130.0	13.046	0.203	0.415	1.066
95	95	96	275.0	8.0	140.0	2.000	0.687	0.398	2.499
96	96	97	310.0	4.0	140.0	0.750	3.684	0.597	11.883
97	96	98	1220.0	8.0	140.0	1.250	1.277	0.249	1.047
98	95	99	1110.0	20.0	130.0	11.046	0.870	0.352	0.783
99	99	100	275.0	6.5	140.0	1.229	0.767	0.370	2.788
100	100	101	190.0	5.0	140.0	0.778	0.815	0.396	4.288
101	100	102	150.0	3.2	140.0	0.257	0.725	0.319	4.836
102	99	103	50.0	15.0	140.0	9.818	0.111	0.556	2.228
103	103	104	750.0	8.0	140.0	2.139	2.123	0.426	2.830
104	103	105	940.0	15.0	140.0	7.679	1.329	0.435	1.414
105	105	106	400.0	6.5	140.0	1.167	1.013	0.352	2.532
106	105	107	400.0	10.0	140.0	4.373	1.436	0.557	3.590
107	107	108	330.0	8.0	140.0	1.643	0.573	0.327	1.736
108	108	109	980.0	8.0	140.0	0.962	0.632	0.191	0.645
109	108	110	90.0	4.0	140.0	0.194	0.088	0.155	0.975
110	107	111	800.0	6.5	140.0	0.980	1.467	0.295	1.833
111	72	112	950.0	15.0	140.0	10.844	2.545	0.614	2.679
112	112	113	300.0	6.5	140.0	1.366	1.016	0.411	3.386
113	113	114	115.0	3.2	140.0	0.393	1.223	0.488	10.632
114	113	115	220.0	4.0	140.0	0.778	2.797	0.619	12.712
115	112	116	485.0	12.5	140.0	9.479	2.461	0.772	5.074
116	116	117	150.0	8.0	140.0	2.442	0.543	0.486	3.618
117	117	118	460.0	5.0	140.0	0.420	0.630	0.214	1.370
118	117	119	150.0	3.2	140.0	0.272	0.809	0.338	5.391
119	117	120	580.0	8.0	140.0	1.750	1.132	0.348	1.952
120	116	131	340.0	12.5	140.0	3.877	0.329	0.316	0.969
121	131	132	140.0	2.5	140.0	0.177	1.131	0.360	8.076
122	131	133	650.0	12.5	140.0	3.016	0.396	0.246	0.609
123	133	134	1100.0	12.5	140.0	3.016	0.669	0.246	0.609
124	134	135	230.0	8.0	140.0	1.071	0.181	0.213	0.787
125	135	136	70.0	3.2	140.0	0.099	0.058	0.123	0.831
126	135	137	120.0	4.0	140.0	0.389	0.423	0.309	3.521
127	134	138	680.0	6.5	140.0	1.556	2.933	0.469	4.314
128	131	81	1800.0	6.5	140.0	0.684	1.697	0.206	0.943
129	116	121	255.0	10.0	140.0	3.160	0.501	0.402	1.966
130	121	122	120.0	3.2	140.0	0.389	1.253	0.484	10.439
131	121	123	600.0	10.0	140.0	2.771	0.925	0.353	1.542
132	123	124	310.0	3.2	140.0	0.194	0.896	0.242	2.890
133	123	125	1100.0	10.0	140.0	2.576	1.482	0.328	1.348
134	125	126	530.0	8.0	140.0	1.604	0.880	0.319	1.661
135	126	127	155.0	5.0	140.0	0.292	0.108	0.149	0.697
136	126	128	100.0	4.0	140.0	0.146	0.057	0.116	0.572
137	125	129	250.0	4.0	140.0	0.389	0.880	0.309	3.521
138	125	130	270.0	5.0	140.0	0.486	0.485	0.248	1.795

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	113.357	100.200	13.16
2	0.62500	110.474	99.870	10.60

3	0.00000	112.353	100.410	11.94
4	0.64360	109.999	100.180	9.82
5	0.00000	112.122	100.240	11.88
6	0.48610	109.755	99.870	9.88
7	0.11670	110.817	99.430	11.39
8	0.12500	110.392	99.400	10.99
9	0.25000	110.535	99.100	11.44
10	0.12500	110.143	98.830	11.31
11	0.37500	105.751	98.760	6.99
12	0.56940	109.747	98.600	11.15
13	0.97220	106.344	98.500	7.84
14	0.70970	109.071	98.400	10.67
15	0.24310	106.304	98.300	8.00
16	0.38890	104.842	98.180	6.66
17	0.38890	105.260	98.200	7.06
18	0.00000	107.958	97.220	10.74
19	0.00000	107.389	95.780	11.61
20	0.58330	104.293	95.600	8.69
21	0.58330	105.462	95.700	9.76
22	0.97220	103.842	94.980	8.86
23	0.48610	103.174	95.680	7.49
24	0.38890	106.060	96.000	10.06
25	0.24310	105.667	96.200	9.47
26	0.24310	104.169	96.400	7.77
27	0.00000	107.580	96.700	10.88
28	0.19440	105.656	97.830	7.83
29	0.00000	107.286	97.000	10.29
30	0.29170	105.999	96.800	9.20
31	0.00000	107.075	96.900	10.18
32	0.29170	105.972	96.720	9.25
33	0.00000	104.803	97.610	7.19
34	0.52110	104.426	97.400	7.03
35	0.00000	104.367	97.320	7.05
36	0.77780	104.181	97.230	6.95
37	0.34030	104.400	97.620	6.78
38	0.97220	103.723	96.970	6.75
39	0.58330	104.322	97.510	6.81
40	0.24305	104.056	97.480	6.58
41	0.77780	103.545	96.700	6.84
42	0.38890	104.522	97.520	7.00
43	0.97220	104.397	97.480	6.92
44	0.58330	104.463	97.480	6.98
45	0.11670	104.227	97.300	6.93
46	0.58330	103.267	96.420	6.85
47	0.00000	111.767	100.360	11.41
48	0.24890	111.356	100.100	11.26
49	0.09916	110.621	100.260	10.36
50	0.19440	110.361	99.820	10.54
51	0.48610	107.150	99.730	7.42
52	0.00000	110.938	100.210	10.73
53	1.75000	107.585	99.710	7.88
54	0.00000	110.295	99.870	10.43
55	0.71360	106.719	99.800	6.92
56	0.00000	109.589	99.730	9.86
57	0.29170	109.104	99.640	9.46
58	0.38890	106.807	99.810	7.00
59	0.38890	106.912	99.450	7.46
60	0.00000	108.756	99.520	9.24
61	0.38890	107.347	99.000	8.35
62	0.00000	108.195	99.500	8.69
63	0.44330	107.495	99.690	7.80
64	0.29167	106.472	98.520	7.95
65	0.00000	106.779	99.500	7.28
66	1.39220	106.051	99.480	6.57
67	0.00000	107.737	99.400	8.34
68	0.00000	106.417	98.860	7.56
69	0.38890	106.179	98.780	7.40
70	1.94440	107.113	98.600	8.51
71	0.58330	106.106	98.420	7.69
72	0.00000	113.292	99.970	13.32
73	0.00000	112.261	99.670	12.59
74	1.16670	106.400	98.020	8.38
75	1.16670	108.526	99.500	9.03
76	0.00000	110.107	99.800	10.31
77	0.00000	109.359	99.700	9.66
78	0.00000	108.830	99.600	9.23
79	1.50000	106.310	99.430	6.88
80	0.25000	107.520	99.830	7.69
81	0.68440	106.259	98.530	7.73
82	0.00000	108.451	99.500	8.95
83	0.62500	106.585	99.530	7.06
84	1.25000	107.571	99.760	7.81
85	1.00000	104.616	98.400	6.22
86	0.50000	105.730	99.300	6.43
87	0.00000	107.524	99.640	7.88
88	0.00000	106.438	98.530	7.91
89	1.37500	105.664	98.450	7.21
90	0.00000	107.511	99.000	8.51
91	0.25000	106.132	98.930	7.20

92	1.28720	104.804	97.760	7.04
93	0.00000	108.723	99.000	9.72
94	0.50000	105.583	98.860	6.72
95	0.00000	108.521	99.000	9.52
96	0.00000	107.834	98.650	9.18
97	0.75000	104.150	97.830	6.32
98	1.25000	106.557	98.580	7.98
99	0.00000	107.651	98.730	8.92
100	0.19440	106.885	98.610	8.27
101	0.77780	106.070	98.550	7.52
102	0.25670	106.159	98.570	7.59
103	0.00000	107.540	98.750	8.79
104	2.13890	105.417	97.600	7.82
105	2.13890	106.211	98.460	7.75
106	1.16670	105.198	97.950	7.25
107	1.75000	104.775	97.830	6.95
108	0.48610	104.202	97.500	6.70
109	0.96250	103.570	97.000	6.57
110	0.19440	104.114	97.430	6.68
111	0.98000	103.309	96.330	6.98
112	0.00000	110.747	100.300	10.45
113	0.19440	109.731	99.800	9.93
114	0.39278	108.508	98.600	9.91
115	0.77780	106.934	98.450	8.48
116	0.00000	108.286	100.360	7.93
117	0.00000	107.743	100.390	7.35
118	0.42000	107.113	99.720	7.39
119	0.27220	106.934	99.910	7.02
120	1.75000	106.611	99.870	6.74
121	0.00000	107.784	99.730	8.05
122	0.38890	106.532	99.820	6.71
123	0.00000	106.859	98.400	8.46
124	0.19440	105.963	98.000	7.96
125	0.09720	105.377	97.700	7.68
126	1.16670	104.496	97.870	6.63
127	0.29167	104.388	97.800	6.59
128	0.14580	104.439	97.600	6.84
129	0.38890	104.497	97.480	7.02
130	0.48610	104.892	97.600	7.29
131	0.00000	107.956	99.730	8.23
132	0.17690	106.826	98.760	8.07
133	0.00000	107.561	98.970	8.59
134	0.38890	106.891	98.900	7.99
135	0.58330	106.710	99.000	7.71
136	0.09917	106.652	98.800	7.85
137	0.38890	106.288	98.560	7.73
138	1.55560	103.958	97.800	6.16

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	112.00	850.0	95200.00
20.0	130.0	83.00	8575.0	711725.00
15.0	140.0	41.80	2870.0	119966.00
12.5	140.0	31.50	7005.0	220657.50
10.0	140.0	19.20	3475.0	66720.00
8.0	140.0	13.80	11265.0	155457.00
6.5	140.0	9.60	8550.0	82080.00
5.0	140.0	6.90	4226.0	29159.40
4.0	140.0	6.20	4190.0	25978.00
3.2	140.0	4.10	3775.0	15477.50
2.5	140.0	4.00	780.0	3120.00
		TOTAL COST=		1525540.40

SCHEME 4

MALASA GROUP OF VILLAGES RURAL WATER SUPPLY SCHEME,KANPUR

THIS SYSTEM HAS ONE OVER HEAD TANK

THIS SYSTEM HAS 298 PIPES, 242 JUNCTIONS, 56 LOOPS AND 1 FIXED GRADE NODE

THESE ARE THE RESULTS FOR THE FLOWS IN PIPES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 5 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	10.0	25.0	130.0	45.016	0.036	0.917	3.565	143.81
2	1	2	90.0	25.0	130.0	30.780	0.159	0.627	1.763	
3	2	3	210.0	20.0	130.0	14.859	0.285	0.473	1.357	
4	3	4	110.0	20.0	130.0	14.081	0.135	0.448	1.228	
5	4	5	930.0	20.0	130.0	13.650	1.078	0.434	1.159	
6	5	6	785.0	15.0	130.0	11.375	2.636	0.644	3.357	
7	6	7	1120.0	15.0	130.0	9.217	2.547	0.522	2.274	
8	7	8	1670.0	15.0	130.0	7.408	2.534	0.419	1.517	
9	8	9	60.0	15.0	130.0	7.019	0.082	0.397	1.373	
10	9	10	100.0	15.0	130.0	5.616	0.091	0.318	0.908	
11	10	11	65.0	15.0	130.0	5.007	0.048	0.283	0.734	
12	11	12	240.0	15.0	130.0	4.453	0.142	0.252	0.591	
13	12	13	90.0	12.5	130.0	3.675	0.091	0.299	1.007	
14	13	14	90.0	12.5	130.0	3.169	0.069	0.258	0.765	
15	14	15	220.0	12.5	130.0	2.737	0.128	0.223	0.583	
16	15	16	120.0	12.5	130.0	2.217	0.047	0.181	0.395	
17	16	17	1500.0	12.5	130.0	1.731	0.374	0.141	0.250	
18	2	18	240.0	20.0	130.0	15.708	0.361	0.500	1.504	
19	18	19	1080.0	20.0	130.0	15.264	1.540	0.486	1.426	
20	19	20	100.0	20.0	130.0	13.432	0.113	0.428	1.125	
21	20	21	45.0	20.0	130.0	13.082	0.048	0.416	1.072	
22	21	22	1010.0	20.0	130.0	12.269	0.961	0.391	0.952	
23	22	24	2520.0	20.0	130.0	10.150	1.688	0.323	0.670	
24	24	25	150.0	15.0	130.0	7.746	0.247	0.438	1.648	
25	25	26	990.0	15.0	130.0	7.039	1.366	0.398	1.380	
26	26	27	1420.0	15.0	130.0	6.028	1.471	0.341	1.036	
27	27	28	18.0	12.5	130.0	5.477	0.038	0.446	2.107	
28	28	29	38.0	12.5	130.0	4.958	0.066	0.404	1.749	
29	29	30	103.0	10.0	140.0	3.475	0.242	0.442	2.345	
30	30	23	115.0	8.0	140.0	1.484	0.165	0.295	1.439	
31	23	31	100.0	6.5	140.0	1.484	0.395	0.447	3.955	
32	31	200	100.0	5.0	140.0	0.389	0.119	0.198	1.188	
33	200	32	572.0	4.0	140.0	0.389	2.014	0.309	3.521	
34	1	33	2000.0	20.0	130.0	14.236	2.506	0.453	1.253	
35	33	34	20.0	20.0	130.0	14.055	0.024	0.447	1.224	
36	34	35	60.0	20.0	130.0	13.608	0.069	0.433	1.153	
37	35	36	10.0	20.0	130.0	13.349	0.011	0.425	1.112	
38	36	37	20.0	20.0	130.0	13.232	0.022	0.421	1.094	
39	37	38	20.0	20.0	130.0	13.069	0.021	0.416	1.070	
40	38	39	1050.0	20.0	130.0	12.894	1.095	0.410	1.043	
41	39	201	200.0	15.0	130.0	7.486	0.309	0.424	1.547	
42	201	40	285.0	12.5	130.0	7.486	1.071	0.610	3.759	
43	40	41	35.0	12.5	130.0	6.417	0.102	0.523	2.926	
44	41	42	55.0	12.5	130.0	6.019	0.138	0.490	2.510	
45	42	43	30.0	12.5	130.0	5.630	0.067	0.459	2.218	
46	43	44	140.0	12.5	130.0	5.280	0.276	0.430	1.969	
47	44	45	900.0	12.5	130.0	4.528	1.333	0.369	1.482	
48	45	46	100.0	10.0	140.0	4.126	0.322	0.525	3.224	
49	46	47	125.0	10.0	140.0	3.905	0.364	0.497	2.911	
50	47	48	35.0	10.0	140.0	3.621	0.089	0.461	2.531	
51	48	49	10.0	10.0	140.0	3.520	0.024	0.448	2.402	
52	49	50	1005.0	10.0	140.0	3.247	2.079	0.413	2.068	
53	50	51	60.0	10.0	140.0	2.875	0.099	0.366	1.651	
54	51	52	150.0	8.0	140.0	1.759	0.296	0.350	1.971	
55	52	53	20.0	6.5	140.0	1.040	0.041	0.313	2.046	
56	53	54	1290.0	6.5	140.0	0.661	1.140	0.199	0.884	
57	39	55	1265.0	12.5	130.0	5.408	2.604	0.441	2.059	
58	55	56	70.0	12.5	130.0	4.498	0.102	0.367	1.463	
59	56	57	40.0	12.5	130.0	4.087	0.049	0.333	1.225	
60	57	58	50.0	12.5	130.0	3.874	0.056	0.316	1.110	
61	58	59	90.0	12.5	130.0	3.632	0.089	0.296	0.985	
62	59	60	100.0	12.5	130.0	3.361	0.085	0.274	0.853	
63	60	202	885.0	12.5	130.0	2.958	0.596	0.241	0.673	
64	202	61	1000.0	10.0	140.0	2.958	1.740	0.377	1.740	
65	3	62	90.0	2.5	140.0	0.194	0.866	0.396	9.617	
66	4	63	90.0	2.5	140.0	0.156	0.573	0.317	6.368	
67	5	203	205.0	6.5	140.0	2.119	1.568	0.639	7.648	
68	203	64	300.0	5.0	140.0	2.119	8.234	1.079	27.446	

69	64	65	60.0	5.0	140.0	1.769	1.179	0.901	19.647
70	65	66	60.0	5.0	140.0	1.480	0.847	0.754	14.124
71	66	67	30.0	5.0	140.0	0.993	0.202	0.506	6.741
72	67	68	90.0	5.0	140.0	0.722	0.336	0.368	3.735
73	68	204	30.0	4.0	140.0	0.389	0.105	0.309	3.517
74	204	69	30.0	3.2	140.0	0.389	0.313	0.483	10.425
75	69	70	30.0	3.2	140.0	0.251	0.139	0.312	4.643
76	70	71	90.0	2.5	140.0	0.097	0.240	0.198	2.664
77	64	75	275.0	2.5	140.0	0.253	4.302	0.515	15.643
78	56	74	75.0	3.2	140.0	0.293	0.464	0.364	6.181
79	74	69	135.0	2.5	140.0	0.115	0.493	0.235	3.653
80	65	74	140.0	2.5	140.0	0.192	1.311	0.390	9.364
81	67	73	85.0	2.5	140.0	0.174	0.665	0.354	7.823
82	70	72	80.0	2.5	140.0	0.076	0.135	0.155	1.693
83	68	73	50.0	2.5	140.0	0.158	0.329	0.323	6.575
84	73	72	95.0	2.5	140.0	0.118	0.364	0.241	3.834
85	6	205	860.0	6.5	140.0	2.158	6.804	0.650	7.912
86	205	76	50.0	5.0	140.0	2.158	1.420	1.099	28.391
87	76	77	180.0	5.0	140.0	1.023	1.283	0.521	7.128
88	77	78	110.0	4.0	140.0	0.407	0.421	0.324	3.830
89	76	79	160.0	5.0	140.0	1.057	1.211	0.538	7.571
90	79	80	225.0	4.0	140.0	0.288	0.455	0.229	2.022
91	79	81	40.0	4.0	140.0	0.477	0.206	0.380	5.146
92	81	82	70.0	3.2	140.0	0.058	0.021	0.072	0.304
93	81	80	100.0	4.0	140.0	0.323	0.249	0.257	2.490
94	80	78	60.0	3.2	140.0	0.086	0.038	0.107	0.635
95	77	82	30.0	3.2	140.0	0.266	0.155	0.331	5.181
96	82	78	120.0	3.2	140.0	0.168	0.266	0.209	2.215
97	7	83	730.0	6.5	140.0	1.809	4.162	0.545	5.702
98	83	84	75.0	5.0	140.0	0.965	0.479	0.491	6.388
99	84	85	60.0	4.0	140.0	0.520	0.361	0.413	6.022
100	85	86	15.0	3.2	140.0	0.267	0.078	0.332	5.195
101	86	87	30.0	2.5	140.0	0.092	0.072	0.187	2.396
102	83	88	105.0	5.0	140.0	0.766	0.438	0.390	4.169
103	88	206	30.0	4.0	140.0	0.533	0.189	0.424	6.306
104	206	89	15.0	3.2	140.0	0.533	0.280	0.662	18.693
105	89	90	20.0	3.2	140.0	0.311	0.138	0.387	6.904
106	90	91	90.0	2.5	140.0	0.117	0.336	0.238	3.738
107	89	87	90.0	3.2	140.0	0.105	0.083	0.130	0.922
108	95	96	120.0	3.2	140.0	0.156	0.230	0.193	1.914
109	87	94	90.0	2.5	140.0	0.156	0.573	0.317	6.368
110	84	87	75.0	3.2	140.0	0.309	0.511	0.384	6.815
111	88	93	60.0	2.5	140.0	0.078	0.106	0.158	1.761
112	90	92	60.0	2.5	140.0	0.097	0.160	0.198	2.664
113	8	207	160.0	3.2	140.0	0.194	0.462	0.242	2.890
114	207	109	250.0	2.5	140.0	0.194	2.404	0.396	9.617
115	9	97	70.0	6.5	140.0	1.053	0.147	0.317	2.095
116	97	98	120.0	2.5	140.0	0.194	1.154	0.396	9.617
117	9	99	60.0	3.2	140.0	0.156	0.115	0.194	1.916
118	99	10	50.0	2.5	140.0	0.013	0.003	0.026	0.063
119	10	208	20.0	3.2	140.0	0.291	0.122	0.362	6.117
120	208	100	100.0	2.5	140.0	0.291	2.035	0.594	20.352
121	99	97	70.0	2.5	140.0	0.046	0.046	0.093	0.656
122	97	209	40.0	3.2	140.0	0.671	1.147	0.835	28.683
123	209	100	10.0	2.5	140.0	0.671	0.954	1.367	95.443
124	100	102	60.0	3.2	140.0	0.418	0.717	0.520	11.943
125	102	210	50.0	3.2	140.0	0.194	0.145	0.242	2.890
126	210	103	100.0	2.5	140.0	0.194	0.962	0.396	9.617
127	100	101	220.0	2.5	140.0	0.194	2.116	0.396	9.617
128	11	104	80.0	2.5	140.0	0.418	3.174	0.851	39.678
129	104	105	115.0	2.5	140.0	0.253	1.799	0.515	15.643
130	102	104	80.0	2.5	140.0	0.127	0.348	0.258	4.348
131	12	106	135.0	2.5	140.0	0.194	1.298	0.396	9.617
132	13	107	120.0	2.5	140.0	0.175	0.950	0.357	7.916
133	14	15	240.0	5.0	140.0	0.258	0.133	0.131	0.554
134	16	108	150.0	2.5	140.0	0.292	3.059	0.594	20.391
135	17	110	90.0	10.0	140.0	1.016	0.022	0.129	0.241
136	110	111	450.0	6.5	140.0	0.389	0.149	0.117	0.331
137	17	112	200.0	6.5	140.0	0.423	0.077	0.127	0.386
138	110	112	100.0	5.0	140.0	0.258	0.056	0.131	0.556
139	15	113	75.0	4.0	140.0	1.695	4.036	1.349	53.811
140	113	114	110.0	4.0	140.0	1.209	3.166	0.962	28.780
141	114	115	130.0	4.0	140.0	0.693	0.308	0.551	10.256
142	115	116	90.0	3.2	140.0	0.245	0.401	0.305	4.452
143	21	211	200.0	3.2	140.0	0.716	6.463	0.890	32.313
144	211	117	10.0	2.5	140.0	0.716	1.075	1.458	107.519
145	117	118	60.0	2.5	140.0	0.113	0.211	0.230	3.523
146	114	116	80.0	2.5	140.0	0.186	0.708	0.379	8.854
147	115	119	90.0	2.5	140.0	0.175	0.712	0.357	7.916
148	115	119	90.0	2.5	140.0	0.175	0.712	0.357	7.916
149	116	212	30.0	2.5	140.0	0.058	0.031	0.119	1.034
150	117	120	30.0	2.5	140.0	0.117	0.112	0.238	3.738
151	113	213	125.0	2.5	140.0	0.292	2.549	0.594	20.391
152	22	214	35.0	5.0	140.0	2.119	1.043	1.079	27.448
153	214	121	42.0	4.0	140.0	2.119	3.418	1.687	81.370
154	121	122	40.0	4.0	140.0	1.778	2.351	1.415	58.783
155	122	123	70.0	4.0	140.0	1.022	1.476	0.813	21.087
156	123	124	25.0	4.0	140.0	0.595	0.193	0.473	7.729
157	124	125	45.0	4.0	140.0	0.400	0.167	0.318	3.712

158	125	126	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.270	2.728
159	126	127	150.0	3.2	140.0	0.195	0.434	0.242	2.894
160	122	215	25.0	3.2	140.0	0.639	0.655	0.795	26.199
161	215	128	5.0	2.5	140.0	0.639	0.436	1.302	87.176
162	128	129	15.0	2.5	140.0	0.429	0.623	0.872	41.529
163	121	130	270.0	2.5	140.0	0.263	4.559	0.537	16.887
164	129	130	40.0	2.5	140.0	0.223	0.494	0.453	12.360
165	130	127	40.0	2.5	140.0	0.136	0.199	0.277	4.967
166	129	126	45.0	2.5	140.0	0.147	0.259	0.300	5.758
167	128	125	210.0	2.5	140.0	0.114	0.748	0.232	3.561
168	123	131	80.0	4.0	140.0	0.233	0.109	0.186	1.367
169	24	132	55.0	6.5	140.0	2.307	0.492	0.695	8.947
170	132	216	35.0	6.5	140.0	1.762	0.190	0.531	5.432
171	215	133	65.0	5.0	140.0	1.762	1.267	0.897	19.492
172	133	134	30.0	4.0	140.0	1.303	0.991	1.037	33.029
173	134	217	40.0	4.0	140.0	0.681	0.397	0.542	9.930
174	217	135	20.0	3.2	140.0	0.681	0.589	0.846	29.438
175	135	136	45.0	3.2	140.0	0.408	0.514	0.508	11.429
176	136	218	50.0	3.2	140.0	0.156	0.096	0.193	1.914
177	218	141	10.0	2.5	140.0	0.156	0.064	0.317	6.368
178	25	219	60.0	3.2	140.0	0.357	0.536	0.444	8.931
179	219	137	50.0	2.5	140.0	0.357	1.486	0.728	29.716
180	132	220	100.0	3.2	140.0	0.428	1.248	0.532	12.475
181	220	138	60.0	2.5	140.0	0.428	2.491	0.872	41.510
182	134	138	34.0	2.5	140.0	0.408	1.290	0.831	37.946
183	136	139	45.0	3.2	140.0	0.156	0.086	0.193	1.914
184	135	140	60.0	2.5	140.0	0.156	0.382	0.317	6.368
185	133	137	55.0	2.5	140.0	0.148	0.320	0.302	5.913
186	26	144	5.0	3.2	140.0	0.817	0.206	1.015	41.230
187	144	142	55.0	3.2	140.0	0.454	0.765	0.565	13.917
188	142	143	50.0	2.5	140.0	0.245	0.739	0.499	14.770
189	143	148	60.0	2.5	140.0	0.097	0.160	0.198	2.664
190	144	221	60.0	3.2	140.0	0.343	0.496	0.426	8.267
191	221	145	10.0	2.5	140.0	0.343	0.275	0.698	27.507
192	145	146	90.0	2.5	140.0	0.183	0.771	0.372	8.565
193	146	147	30.0	2.5	140.0	0.058	0.031	0.119	1.034
194	142	145	105.0	2.5	140.0	0.015	0.009	0.030	0.081
195	143	146	55.0	3.2	140.0	0.090	0.038	0.111	0.688
196	27	153	248.0	5.0	140.0	0.551	0.562	0.281	2.265
197	153	155	60.0	4.0	140.0	0.169	0.045	0.134	0.751
198	30	154	60.0	6.5	140.0	1.018	0.118	0.307	1.966
199	154	156	171.0	5.0	140.0	0.617	0.477	0.314	2.791
200	154	155	48.0	2.5	140.0	0.103	0.143	0.210	2.982
201	30	152	66.0	5.0	140.0	0.487	0.119	0.248	1.801
202	152	154	40.0	4.0	140.0	0.014	0.000	0.011	0.007
203	152	153	51.0	4.0	140.0	0.279	0.097	0.222	1.903
204	31	156	120.0	5.0	140.0	0.180	0.034	0.092	0.286
205	29	149	135.0	6.5	140.0	1.186	0.352	0.357	2.611
206	149	150	32.0	5.0	140.0	0.835	0.156	0.425	4.889
207	150	151	164.0	5.0	140.0	0.486	0.295	0.248	1.797
208	151	31	23.0	4.0	140.0	-0.040	-0.001	-0.032	-0.052
209	28	149	162.0	4.0	140.0	0.329	0.419	0.262	2.588
210	150	151	188.0	4.0	140.0	0.251	0.295	0.200	1.570
211	32	157	86.0	5.0	140.0	0.224	0.037	0.114	0.428
212	32	157	152.0	5.0	140.0	0.165	0.037	0.084	0.242
213	35	158	30.0	2.5	140.0	0.103	0.089	0.210	2.970
214	158	159	60.0	2.5	140.0	0.097	0.160	0.198	2.664
215	158	37	30.0	2.5	140.0	-0.047	-0.021	-0.095	-0.684
216	36	161	115.0	2.5	140.0	0.117	0.430	0.238	3.738
217	34	164	70.0	2.5	140.0	0.389	2.431	0.792	34.734
218	164	162	115.0	2.5	140.0	0.117	0.430	0.238	3.738
219	164	163	130.0	2.5	140.0	0.175	1.029	0.357	7.916
220	36	160	45.0	2.5	140.0	0.078	0.079	0.158	1.764
221	33	158	95.0	2.5	140.0	0.084	0.191	0.170	2.015
222	42	165	100.0	2.5	140.0	0.194	0.962	0.396	9.617
223	43	166	195.0	2.5	140.0	0.292	3.976	0.594	20.391
224	41	168	55.0	2.5	140.0	0.204	0.577	0.415	10.494
225	40	167	54.0	5.0	140.0	1.069	0.417	0.544	7.728
226	167	222	125.0	4.0	140.0	0.748	1.477	0.595	11.820
227	222	169	10.0	3.2	140.0	0.748	0.350	0.930	35.040
228	167	168	60.0	2.5	140.0	0.127	0.262	0.258	4.360
229	169	223	10.0	3.2	140.0	0.372	0.096	0.462	9.609
230	223	171	30.0	2.5	140.0	0.372	0.959	0.758	31.973
231	44	170	35.0	2.5	140.0	0.460	1.660	0.937	47.431
232	47	173	77.0	2.5	140.0	0.051	0.062	0.104	0.811
233	171	174	75.0	2.5	140.0	-0.017	-0.008	-0.035	-0.106
234	46	173	140.0	2.5	140.0	0.104	0.426	0.213	3.045
235	49	174	75.0	2.5	140.0	0.173	0.579	0.352	7.717
236	45	172	115.0	4.0	140.0	0.402	0.430	0.320	3.739
237	172	175	75.0	3.2	140.0	0.211	0.252	0.262	3.354
238	175	49	155.0	2.5	140.0	0.055	0.144	0.112	0.930
239	172	48	140.0	2.5	140.0	0.094	0.349	0.191	2.494
240	175	176	150.0	2.5	140.0	0.078	0.265	0.158	1.764
241	51	177	120.0	2.5	140.0	0.194	1.154	0.396	9.617
242	52	224	60.0	3.2	140.0	0.194	0.173	0.242	2.890
243	224	180	60.0	2.5	140.0	0.194	0.577	0.395	9.617
244	50	178	55.0	4.0	140.0	0.372	0.178	0.296	3.236
245	178	179	180.0	4.0	140.0	0.236	0.251	0.188	1.393
246	51	178	75.0	6.5	140.0	0.727	0.079	0.219	1.055

247	178	225	80.0	5.0	140.0	0.416	0.108	0.212	1.345
248	225	179	35.0	4.0	140.0	0.416	0.140	0.331	3.986
249	179	226	15.0	4.0	140.0	0.068	0.002	0.054	0.140
250	226	53	65.0	3.2	140.0	0.068	0.027	0.085	0.416
251	54	227	125.0	3.2	140.0	0.272	0.674	0.338	5.391
252	227	181	25.0	2.5	140.0	0.272	0.448	0.555	17.939
253	54	182	120.0	5.0	140.0	0.194	0.039	0.099	0.329
254	55	187	100.0	5.0	140.0	0.572	0.242	0.291	2.423
255	187	188	50.0	5.0	140.0	0.550	0.113	0.280	2.260
256	188	60	30.0	4.0	140.0	0.181	0.026	0.144	0.853
257	55	183	130.0	4.0	140.0	0.339	0.355	0.270	2.728
258	183	240	10.0	3.2	140.0	0.117	0.011	0.145	1.123
259	240	184	80.0	2.5	140.0	0.117	0.299	0.238	3.738
260	183	185	45.0	2.5	140.0	0.028	0.012	0.056	0.261
261	56	186	30.0	3.2	140.0	0.295	0.187	0.366	6.240
262	186	185	25.0	3.2	140.0	0.187	0.067	0.232	2.677
263	185	59	82.0	2.5	140.0	0.020	0.012	0.040	0.140
264	58	186	40.0	2.5	140.0	0.086	0.086	0.176	2.140
265	57	187	25.0	2.5	140.0	0.115	0.091	0.234	3.635
266	188	189	120.0	2.5	140.0	0.292	2.447	0.594	20.391
267	191	192	14.0	6.5	140.0	0.906	0.022	0.273	1.585
268	192	195	113.0	6.5	140.0	0.789	0.139	0.238	1.228
269	195	197	45.0	5.0	140.0	0.575	0.110	0.293	2.454
270	197	241	10.0	4.0	140.0	0.261	0.017	0.208	1.689
271	241	199	40.0	3.2	140.0	0.261	0.200	0.325	5.005
272	199	228	35.0	2.5	140.0	0.106	0.109	0.216	3.128
273	192	193	60.0	2.5	140.0	0.058	0.062	0.119	1.034
274	195	196	30.0	2.5	140.0	0.058	0.031	0.119	1.034
275	197	198	60.0	2.5	140.0	0.197	0.593	0.402	9.875
276	199	194	90.0	2.5	140.0	0.097	0.240	0.198	2.664
277	190	239	50.0	2.5	140.0	0.126	0.215	0.257	4.304
278	235	236	32.0	4.0	140.0	0.609	0.259	0.485	8.078
279	236	232	97.0	4.0	140.0	0.442	0.433	0.352	4.468
280	232	233	36.0	3.2	140.0	0.332	0.281	0.413	7.797
281	233	234	120.0	3.2	140.0	0.156	0.230	0.193	1.914
282	235	237	50.0	3.2	140.0	0.261	0.249	0.325	4.989
283	237	236	55.0	2.5	140.0	0.028	0.014	0.057	0.261
284	230	229	50.0	2.5	140.0	0.097	0.133	0.198	2.664
285	230	233	71.0	2.5	140.0	0.018	0.008	0.036	0.115
286	231	232	70.0	2.5	140.0	0.143	0.380	0.291	5.427
287	237	238	83.0	2.5	140.0	0.136	0.412	0.277	4.969
288	61	190	65.0	8.0	140.0	2.880	0.319	0.573	4.911
289	190	191	18.0	8.0	140.0	2.599	0.073	0.517	4.059
290	191	239	30.0	6.5	140.0	1.635	0.142	0.493	4.728
291	239	235	24.0	6.5	140.0	1.566	0.105	0.472	4.368
292	235	231	118.0	5.0	140.0	0.599	0.312	0.305	2.643
293	231	228	18.0	4.0	140.0	0.301	0.039	0.239	2.185
294	228	242	14.0	3.2	140.0	0.212	0.048	0.264	3.399
295	242	230	50.0	2.5	140.0	0.212	0.566	0.432	11.310
296	18	4	90.0	2.5	140.0	0.055	0.084	0.112	0.932
297	169	95	90.0	3.2	140.0	-0.013	-0.002	-0.016	-0.019
298	95	170	25.0	2.5	140.0	-0.013	-0.002	-0.026	-0.064

THE RELATIVE CHANGE IN FLOWRATE FROM PRIVIOUS TRIAL= 0.00363

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	143.774	123.770	20.00
2	0.21390	143.616	122.890	20.73
3	0.58330	143.331	122.240	21.09
4	0.33060	143.196	122.710	20.49
5	0.15560	142.118	125.510	16.61
6	0.00000	139.482	125.150	14.33
7	0.00000	136.935	125.790	11.15
8	0.19440	134.401	125.030	9.37
9	0.19440	134.319	125.290	9.03
10	0.33060	134.228	124.860	9.37
11	0.13610	134.180	124.310	9.87
12	0.58330	134.038	122.430	11.61
13	0.33060	133.948	124.410	9.54
14	0.17500	133.879	123.530	10.35
15	0.77780	133.751	125.600	8.15
16	0.19440	133.703	124.420	9.28
17	0.29170	133.329	127.570	5.76
18	0.38890	143.255	122.810	20.44
19	0.13610	141.715	125.130	16.58
20	0.35000	141.602	126.340	15.26
21	0.09720	141.554	125.950	15.60
22	0.00000	140.593	126.000	14.59
23	0.00000	135.310		
24	0.09720	138.905	127.870	11.04
25	0.35000	138.658	128.650	10.01
26	0.19440	137.292	129.650	7.64
27	0.00000	135.821	128.210	7.61
28	0.19440	135.783	128.310	7.47

29	0.29170	135.717	128.630	7.09
30	0.48610	135.475	128.970	6.51
31	0.87500	134.914	128.730	6.18
32	0.00000	132.781	125.750	7.03
33	0.09720	141.268	125.810	15.46
34	0.05830	141.244	126.280	14.96
35	0.15560	141.174	126.950	14.22
36	0.03890	141.163	126.590	14.57
37	0.11670	141.097	126.240	14.86
38	0.05830	141.076	126.500	14.58
39	0.00000	139.980	126.330	13.65
40	0.00000	138.600	127.760	10.84
41	0.19440	138.498	127.650	10.85
42	0.19440	138.360	127.120	11.24
43	0.05830	138.293	126.730	11.56
44	0.29170	138.018	127.280	10.74
45	0.00000	136.684	127.570	9.11
46	0.11670	136.362	127.070	9.29
47	0.23330	135.998	127.410	8.59
48	0.19440	135.905	127.000	8.91
49	0.15560	135.886	126.930	8.96
50	0.00000	133.807	126.500	7.31
51	0.19440	133.708	126.370	7.34
52	0.52500	133.413	126.990	6.42
53	0.44720	133.372	127.100	6.27
54	0.19440	132.231	125.810	6.42
55	0.00000	137.376	128.540	8.84
56	0.11670	137.274	128.430	8.84
57	0.09720	137.225	127.050	10.17
58	0.15560	137.169	126.690	10.48
59	0.29170	136.998	126.660	10.34
60	0.58330	136.995	128.240	8.76
61	0.07780	134.659	128.170	6.49
62	0.19440	142.465	121.840	20.63
63	0.15560	142.623	122.820	19.80
64	0.09720	132.316	123.270	9.05
65	0.09720	131.137	122.770	8.37
66	0.19440	130.290	122.560	7.73
67	0.09720	130.087	122.550	7.54
68	0.17500	129.751	122.380	7.37
69	0.25280	129.333	122.000	7.33
70	0.07780	129.194	123.170	6.02
71	0.09720	128.954	122.780	6.17
72	0.19440	129.058	123.180	5.88
73	0.21390	129.423	123.230	6.19
74	0.36940	129.826	122.400	7.43
75	0.25280	128.014	122.270	5.74
76	0.07780	131.258	123.280	7.98
77	0.35000	129.975	123.470	6.51
78	0.66110	129.554	122.650	6.90
79	0.29170	130.047	121.590	8.46
80	0.52500	129.592	122.390	7.20
81	0.09720	129.841	121.980	7.86
82	0.15560	129.820	123.330	6.49
83	0.07780	132.773	126.730	6.04
84	0.13610	132.294	126.010	6.28
85	0.09720	131.932	125.600	6.33
86	0.17500	131.854	125.130	6.72
87	0.35000	131.783	125.110	6.67
88	0.15560	132.335	126.510	5.83
89	0.11670	131.865	125.890	5.98
90	0.09720	131.727	125.900	5.83
91	0.11670	131.391	125.600	5.79
92	0.09720	131.568	125.100	6.47
93	0.07780	132.229	126.450	5.78
94	0.15560	131.209	125.390	5.82
95	0.00000	136.356		
96	0.15560	131.703	125.910	5.79
97	0.23330	134.172	125.720	8.45
98	0.19440	133.018	125.550	7.47
99	0.09720	134.204	125.310	8.89
100	0.35000	132.070	125.150	6.92
101	0.19440	129.955	124.620	5.33
102	0.09720	131.354	124.870	6.48
103	0.19440	130.248	124.900	5.35
104	0.29170	131.006	123.850	7.16
105	0.25280	129.207	122.620	6.59
106	0.19440	132.740	122.840	9.90
107	0.17500	132.998	123.620	9.38
108	0.29170	130.645	124.390	6.25
109	0.19440	131.534	125.730	5.80
110	0.36940	133.307	127.300	6.01
111	0.38890	133.158	127.360	5.80
112	0.68060	133.252	127.450	5.80
113	0.19440	137.679	126.000	11.68
114	0.33060	134.513	125.460	9.05
115	0.09720	134.206	125.470	8.74
116	0.48610	133.805	126.370	7.44
117	0.48610	134.016	125.760	8.26

118	0.17500	133.493	125.050	8.44
119	0.17500	133.493	124.790	8.70
120	0.11670	133.904	125.610	8.29
121	0.07780	136.133	126.260	9.87
122	0.11670	133.781	126.210	7.57
123	0.19440	132.305	126.390	5.92
124	0.19440	132.112	126.150	5.96
125	0.17500	131.945	125.700	6.24
126	0.29170	131.808	125.820	5.99
127	0.33060	131.374	125.000	6.37
128	0.09720	132.690	126.160	6.53
129	0.05830	132.067	126.200	5.87
130	0.35000	131.573	125.200	6.37
131	0.23330	132.196	126.300	5.90
132	0.11670	138.413	128.630	9.78
133	0.31110	136.956	131.150	5.81
134	0.21390	135.965	129.790	6.18
135	0.11670	134.979	129.010	5.97
136	0.09720	134.465	128.720	5.75
137	0.50560	136.636	130.200	6.44
138	0.83610	134.675	128.800	5.88
139	0.15560	134.379	128.700	5.68
140	0.15560	134.597	128.790	5.81
141	0.15560	134.306	128.610	5.70
142	0.19440	136.320	129.410	6.91
143	0.05830	135.582	129.420	6.16
144	0.01940	137.086	130.050	7.04
145	0.17500	136.312	129.640	6.67
146	0.21390	135.544	129.450	6.09
147	0.05830	135.513	129.980	5.53
148	0.09720	135.422	128.800	6.62
149	0.68060	135.364	127.990	7.37
150	0.09720	135.207	128.160	7.05
151	0.77780	134.913	128.610	6.30
152	0.19440	135.356	128.750	6.61
153	0.66110	135.259	128.870	6.39
154	0.31110	135.357	129.440	5.92
155	0.27220	135.214	129.060	6.15
156	0.79720	134.880	128.600	6.28
157	0.38890	132.744	126.990	5.76
158	0.13610	141.077	126.000	15.08
159	0.09720	140.917	125.470	15.45
160	0.07780	141.084	126.820	14.26
161	0.11670	140.646	126.780	13.87
162	0.11670	138.382	126.780	11.60
163	0.17500	137.783	126.780	11.00
164	0.09720	138.812	125.530	13.28
165	0.19440	137.398	127.880	9.52
166	0.29170	134.317	127.280	7.04
167	0.19440	138.182	128.060	10.12
168	0.33060	137.921	127.800	10.12
169	0.38890	136.354	128.510	7.84
170	0.44720	136.358	127.420	8.94
171	0.38890	135.299	127.420	7.88
172	0.09720	136.254	126.630	9.62
173	0.15560	135.936	127.210	8.73
174	0.15560	135.307	127.210	8.10
175	0.07780	136.003	126.840	9.16
176	0.07780	135.738	126.780	8.96
177	0.19440	132.554	126.650	5.90
178	0.44720	133.629	126.890	6.74
179	0.58330	133.379	127.550	5.83
180	0.19440	132.562	127.210	5.45
181	0.27220	131.109	125.350	5.76
182	0.19440	132.192	126.980	5.21
183	0.19440	137.022	128.440	8.58
184	0.11670	136.711	128.630	8.08
185	0.19440	137.010	127.780	9.23
186	0.19440	137.087	127.820	9.27
187	0.13610	137.134	127.410	9.72
188	0.07780	137.021	127.700	9.32
189	0.29170	134.574	127.800	6.77
190	0.15560	134.340	128.140	6.20
191	0.05830	134.266	128.010	6.26
192	0.05830	134.244	127.710	6.53
193	0.05830	134.182	127.970	6.21
194	0.09720	133.538	128.130	5.41
195	0.15560	134.106	127.310	6.80
196	0.05830	134.075	127.360	6.71
197	0.11670	133.995	128.250	5.75
198	0.19720	133.103	128.340	5.06
199	0.05830	133.778	128.400	5.38
200	0.00000	134.795		
201	0.00000	139.671		
202	0.00000	136.399		
203	0.00000	140.550		
204	0.00000	129.646		
205	0.00000	132.678		
206	0.00000	132.146		

207	0.00000	133.939		
208	0.00000	134.106		
209	0.00000	133.025		
210	0.00000	131.209		
211	0.00000	135.092		
212	0.05830	133.774	126.210	7.56
213	0.29170	135.130	126.340	8.79
214	0.00000	139.550		
215	0.00000	133.126		
216	0.00000	138.223		
217	0.00000	135.568		
218	0.00000	134.369		
219	0.00000	138.122		
220	0.00000	137.166		
221	0.00000	136.590		
222	0.00000	136.705		
223	0.00000	136.258		
224	0.00000	133.239		
225	0.00000	133.522		
226	0.00000	133.377		
227	0.00000	131.557		
228	0.19440	133.668	127.790	5.88
229	0.09720	132.922	126.900	6.02
230	0.09720	133.055	127.100	5.96
231	0.15560	133.708	128.160	5.55
232	0.25280	133.328	127.960	5.37
233	0.19440	133.047	127.710	5.34
234	0.15560	132.817	127.600	5.22
235	0.09720	134.020	128.190	5.83
236	0.19440	133.761	127.890	5.87
237	0.09720	133.770	127.460	6.31
238	0.13610	133.358	127.090	6.27
239	0.19440	134.124	128.590	5.53
240	0.00000	137.010		
241	0.00000	133.979		
242	0.00000	133.621		

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
25.0	130.0	55.00	100.0	5500.00
20.0	130.0	40.00	9425.0	377000.00
15.0	130.0	30.00	6800.0	204000.00
12.5	130.0	25.00	6022.0	150550.00
10.0	140.0	17.80	2528.0	44998.40
8.0	140.0	12.70	348.0	4419.60
6.5	140.0	9.70	4466.0	43320.20
5.0	140.0	7.00	3259.0	22813.00
4.0	140.0	4.70	3170.0	14899.00
3.2	140.0	4.15	2860.0	11869.00
2.5	140.0	4.10	8255.0	33845.50
TOTAL COST=				913214.70

THE FOLLOWING CHANGES IN SYSTEM DATA ARE MADE

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS
82	70	72	80.0	8.0	140.0
77	64	75	275.0	3.2	140.0
102	83	88	105.0	6.5	140.0
109	87	94	90.0	3.2	140.0
108	85	96	120.0	4.0	140.0
127	100	101	220.0	3.2	140.0
129	104	105	115.0	3.2	140.0
134	16	108	150.0	3.2	140.0
155	122	123	70.0	5.0	140.0
162	129	129	15.0	3.2	140.0
168	123	131	80.0	5.0	140.0
171	216	133	65.0	6.5	140.0
183	136	139	45.0	4.0	140.0
177	218	141	10.0	3.2	140.0
184	135	140	60.0	3.2	140.0
192	145	146	90.0	4.0	140.0
198	30	154	60.0	10.0	140.0
211	32	157	86.0	6.5	140.0
212	32	157	152.0	6.5	140.0
241	51	177	120.0	3.2	140.0
243	224	180	60.0	4.0	140.0
245	178	179	180.0	6.5	140.0
269	195	197	45.0	10.0	140.0
275	197	198	60.0	6.5	140.0
271	241	199	40.0	8.0	140.0
276	199	194	90.0	5.0	140.0
251	54	227	125.0	4.0	140.0
272	199	228	35.0	3.2	140.0
291	239	235	24.0	10.0	140.0
295	242	230	50.0	3.2	140.0
292	235	231	118.0	10.0	140.0
277	190	239	50.0	10.0	140.0
286	231	232	70.0	4.0	140.0
280	232	233	36.0	5.0	140.0
281	233	234	120.0	4.0	140.0
278	235	236	32.0	5.0	140.0
126	210	103	100.0	3.2	140.0
114	207	109	250.0	3.2	140.0
174	217	135	20.0	4.0	140.0
175	135	136	45.0	4.0	140.0
193	146	147	30.0	5.0	140.0
23	200	32	572.0	5.0	140.0
56	53	54	1290.0	8.0	140.0
253	54	182	120.0	6.5	140.0
290	191	239	30.0	10.0	140.0
17	16	17	1500.0	15.0	130.0
75	69	70	30.0	4.0	140.0
84	73	72	90.0	3.2	140.0
268	192	195	113.0	10.0	140.0
288	61	190	65.0	10.0	140.0
136	110	111	450.0	8.0	140.0
137	17	112	200.0	8.0	140.0
133	14	15	240.0	8.0	140.0

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	10.0	25.0	130.0	45.016	0.036	0.917	3.565	143.81
2	1	2	90.0	25.0	130.0	30.780	0.159	0.627	1.763	
3	2	3	210.0	20.0	130.0	14.868	0.285	0.473	1.358	
4	3	4	110.0	20.0	130.0	14.090	0.135	0.449	1.229	
5	4	5	930.0	20.0	130.0	13.650	1.078	0.434	1.159	
6	5	6	785.0	15.0	130.0	11.375	2.636	0.644	3.357	
7	6	7	1120.0	15.0	130.0	9.217	2.547	0.522	2.274	
8	7	8	1670.0	15.0	130.0	7.408	2.534	0.419	1.517	
9	8	9	60.0	15.0	130.0	7.019	0.082	0.397	1.373	
10	9	10	100.0	15.0	130.0	5.637	0.091	0.319	0.915	
11	10	11	65.0	15.0	130.0	5.007	0.048	0.283	0.734	
12	11	12	240.0	15.0	130.0	4.453	0.142	0.252	0.591	
13	12	13	90.0	12.5	130.0	3.675	0.091	0.299	1.007	
14	13	14	90.0	12.5	130.0	3.169	0.069	0.258	0.765	
15	14	15	220.0	12.5	130.0	2.272	0.091	0.185	0.413	
16	15	16	120.0	12.5	130.0	2.217	0.047	0.181	0.395	
17	16	17	1500.0	15.0	130.0	1.731	0.154	0.098	0.103	
18	2	18	240.0	20.0	130.0	15.699	0.360	0.500	1.502	
19	18	19	1080.0	20.0	130.0	15.264	1.540	0.486	1.426	
20	19	20	100.0	20.0	130.0	13.432	0.113	0.428	1.125	
21	20	21	45.0	20.0	130.0	13.082	0.048	0.416	1.072	
22	21	22	1010.0	20.0	130.0	12.269	0.961	0.391	0.952	

23	22	23	2520.0	20.0	130.0	10.150	1.688	0.323	0.670
24	24	25	150.0	15.0	130.0	7.680	0.244	0.435	1.625
25	25	26	990.0	15.0	130.0	7.039	1.366	0.398	1.380
26	26	27	1420.0	15.0	130.0	6.029	1.471	0.341	1.036
27	27	28	18.0	12.5	130.0	5.505	0.038	0.449	2.128
28	28	29	38.0	12.5	130.0	4.983	0.067	0.406	1.769
29	29	30	103.0	10.0	140.0	3.514	0.247	0.447	2.394
30	30	23	115.0	8.0	140.0	1.453	0.159	0.289	1.383
31	23	31	100.0	6.5	140.0	1.453	0.380	0.438	3.902
32	31	200	100.0	5.0	140.0	0.389	0.119	0.198	1.188
33	200	32	572.0	5.0	140.0	0.389	0.679	0.198	1.188
34	1	33	2000.0	20.0	130.0	14.236	2.506	0.453	1.253
35	33	34	20.0	20.0	130.0	14.061	0.024	0.448	1.225
36	34	35	60.0	20.0	130.0	13.614	0.069	0.433	1.154
37	35	36	10.0	20.0	130.0	13.367	0.011	0.425	1.115
38	36	37	20.0	20.0	130.0	13.251	0.022	0.422	1.097
39	37	38	20.0	20.0	130.0	13.069	0.021	0.416	1.070
40	38	39	1050.0	20.0	130.0	12.894	1.095	0.410	1.043
41	39	201	200.0	15.0	130.0	7.486	0.309	0.424	1.547
42	201	40	285.0	12.5	130.0	7.486	1.071	0.610	3.759
43	40	41	36.0	12.5	130.0	6.417	0.102	0.523	2.826
44	41	42	55.0	12.5	130.0	6.018	0.138	0.490	2.510
45	42	43	30.0	12.5	130.0	5.630	0.067	0.459	2.218
46	43	44	140.0	12.5	130.0	5.280	0.276	0.430	1.959
47	44	45	900.0	12.5	130.0	4.528	1.333	0.369	1.482
48	45	46	100.0	10.0	140.0	4.129	0.323	0.526	3.227
49	46	47	125.0	10.0	140.0	3.908	0.364	0.498	2.915
50	47	48	35.0	10.0	140.0	3.623	0.089	0.461	2.534
51	48	49	10.0	10.0	140.0	3.523	0.024	0.449	2.406
52	49	50	1005.0	10.0	140.0	3.247	2.079	0.413	2.068
53	50	51	60.0	10.0	140.0	2.861	0.098	0.364	1.636
54	51	52	150.0	8.0	140.0	1.677	0.271	0.334	1.803
55	52	53	20.0	6.5	140.0	0.957	0.035	0.289	1.756
56	53	54	1290.0	8.0	140.0	0.661	0.415	0.132	0.322
57	33	55	1265.0	12.5	130.0	5.408	2.604	0.441	2.059
58	55	56	70.0	12.5	130.0	4.514	0.103	0.368	1.473
59	56	57	40.0	12.5	130.0	4.119	0.050	0.336	1.243
60	57	58	50.0	12.5	130.0	3.906	0.056	0.318	1.127
61	58	59	90.0	12.5	130.0	3.678	0.091	0.300	1.008
62	59	60	100.0	12.5	130.0	3.357	0.085	0.274	0.851
63	60	202	885.0	12.5	130.0	2.958	0.596	0.241	0.673
64	202	61	1000.0	10.0	140.0	2.958	1.740	0.377	1.740
65	3	62	90.0	2.5	140.0	0.194	0.866	0.396	9.617
66	4	63	90.0	2.5	140.0	0.156	0.573	0.317	6.368
67	5	203	205.0	6.5	140.0	2.119	1.568	0.639	7.648
68	203	64	300.0	5.0	140.0	2.119	8.234	1.079	27.446
69	64	65	60.0	5.0	140.0	1.769	1.179	0.901	19.647
70	65	66	60.0	5.0	140.0	1.481	0.848	0.754	14.127
71	66	67	30.0	5.0	140.0	0.994	0.203	0.506	6.753
72	67	68	90.0	5.0	140.0	0.721	0.335	0.367	3.726
73	68	204	30.0	4.0	140.0	0.384	0.103	0.305	3.442
74	204	69	30.0	3.2	140.0	0.384	0.306	0.478	10.202
75	69	70	30.0	4.0	140.0	0.246	0.045	0.195	1.504
76	70	71	90.0	2.5	140.0	0.097	0.240	0.198	2.664
77	64	75	275.0	3.2	140.0	0.253	1.293	0.314	4.701
78	66	74	75.0	3.2	140.0	0.292	0.461	0.363	6.151
79	74	69	135.0	2.5	140.0	0.114	0.486	0.233	3.599
80	65	74	140.0	2.5	140.0	0.191	1.309	0.390	9.349
81	57	73	85.0	2.5	140.0	0.176	0.678	0.358	7.976
82	70	72	80.0	8.0	140.0	0.071	0.000	0.014	0.095
83	65	73	50.0	2.5	140.0	0.162	[illegible]	0.330	5.855
84	73	72	[illegible]	3.2	140.0	0.124	1.113	0.153	1.252
85	[illegible]	205	[illegible]	5.5	140.0	2.158	6.804	0.655	7.872
86	[illegible]	[illegible]	50.0	5.0	140.0	2.159	1.420	1.599	28.391
87	75	77	[illegible]	5.0	140.0	1.023	1.283	0.521	7.128
88	77	78	110.0	4.0	140.0	0.407	0.421	0.321	[illegible]
89	76	79	160.0	5.0	140.0	1.057	1.271	0.538	7.571
90	78	80	225.0	4.0	140.0	0.288	0.155	0.229	2.022
91	79	81	40.0	4.0	140.0	0.477	0.206	0.380	5.146
92	81	82	70.0	3.2	140.0	0.058	0.021	0.072	0.304
93	81	80	100.0	4.0	140.0	0.323	0.249	0.257	2.490
94	80	78	60.0	3.2	140.0	0.086	0.038	0.107	0.635
95	77	62	30.0	3.2	140.0	0.266	0.155	0.331	5.181
96	82	78	120.0	3.2	140.0	0.168	0.266	0.209	2.215
97	7	83	730.0	6.5	140.0	1.809	4.162	0.545	5.702
98	83	84	75.0	5.0	140.0	0.913	0.433	0.465	5.773
99	84	85	60.0	4.0	140.0	0.494	0.330	0.393	5.492
100	85	86	15.0	3.2	140.0	0.242	0.065	0.300	4.322
101	86	87	30.0	2.5	140.0	0.067	0.040	0.136	1.322
102	83	88	105.0	6.5	140.0	0.817	0.138	0.246	1.310
103	88	206	30.0	4.0	140.0	0.584	0.224	0.465	7.478
104	206	89	15.0	3.2	140.0	0.584	0.333	0.726	22.168
105	89	90	20.0	3.2	140.0	0.311	0.138	0.387	6.904
106	90	91	90.0	2.5	140.0	0.117	0.336	0.238	3.738
107	89	87	90.0	3.2	140.0	0.156	0.174	0.194	1.928
108	85	96	120.0	4.0	140.0	0.156	0.077	0.124	0.646
109	87	94	90.0	3.2	140.0	0.156	0.172	0.193	1.914
110	84	87	75.0	3.2	140.0	0.283	0.434	0.352	5.785
111	88	93	60.0	2.5	140.0	0.078	0.106	0.158	1.764

112	90	97	60.0	2.5	140.0	0.097	0.160	0.198	2.664
113	8	207	160.0	3.2	140.0	0.194	0.462	0.242	2.890
114	207	109	250.0	3.2	140.0	0.194	0.723	0.242	2.890
115	9	97	70.0	6.5	140.0	1.050	0.146	0.316	2.082
116	97	98	120.0	2.5	140.0	0.194	1.154	0.396	9.617
117	9	99	60.0	3.2	140.0	0.138	0.093	0.172	1.542
118	99	10	50.0	2.5	140.0	-0.008	-0.001	-0.017	-0.027
119	10	208	20.0	3.2	140.0	0.291	0.122	0.362	6.114
120	208	100	100.0	2.5	140.0	0.291	2.034	0.593	20.344
121	99	97	70.0	2.5	140.0	0.049	0.053	0.101	0.761
122	97	209	40.0	3.2	140.0	0.671	1.148	0.835	28.692
123	209	100	10.0	2.5	140.0	0.671	0.955	1.368	95.472
124	100	102	60.0	3.2	140.0	0.418	0.717	0.521	11.946
125	102	210	50.0	3.2	140.0	0.194	0.145	0.242	2.890
126	210	103	100.0	3.2	140.0	0.194	0.260	0.242	2.890
127	100	101	220.0	3.2	140.0	0.194	0.636	0.242	2.890
128	11	104	80.0	2.5	140.0	0.418	3.174	0.851	39.671
129	104	105	115.0	3.2	140.0	0.253	0.541	0.314	4.701
130	102	104	80.0	2.5	140.0	0.127	0.348	0.258	4.350
131	12	106	135.0	2.5	140.0	0.194	1.298	0.396	9.617
132	13	107	120.0	2.5	140.0	0.175	0.950	0.357	7.916
133	14	15	240.0	8.0	140.0	0.722	0.091	0.144	0.379
134	16	108	150.0	3.2	140.0	0.292	0.919	0.363	6.128
135	17	110	90.0	10.0	140.0	0.919	0.018	0.117	0.200
136	110	111	450.0	8.0	140.0	0.389	0.054	0.077	0.120
137	17	112	200.0	8.0	140.0	0.520	0.041	0.103	0.206
138	110	112	100.0	5.0	140.0	0.161	0.023	0.082	0.232
139	19	113	75.0	4.0	140.0	1.695	4.036	1.349	53.811
140	113	114	110.0	4.0	140.0	1.209	3.166	0.962	28.780
141	114	115	30.0	4.0	140.0	0.693	0.308	0.551	10.256
142	115	116	90.0	3.2	140.0	0.245	0.401	0.305	4.452
143	21	211	200.0	3.2	140.0	0.716	6.463	0.890	32.313
144	211	117	10.0	2.5	140.0	0.716	1.075	1.458	107.519
145	117	116	60.0	2.5	140.0	0.113	0.211	0.230	3.523
146	114	116	80.0	2.5	140.0	0.186	0.708	0.379	8.854
147	115	118	90.0	2.5	140.0	0.175	0.712	0.357	7.916
148	115	119	90.0	2.5	140.0	0.175	0.712	0.357	7.916
149	116	212	30.0	2.5	140.0	0.058	0.031	0.119	1.034
150	117	120	30.0	2.5	140.0	0.117	0.112	0.238	3.738
151	113	213	125.0	2.5	140.0	0.292	2.549	0.594	20.391
152	22	214	38.0	5.0	140.0	2.119	1.043	1.079	27.448
153	214	121	42.0	4.0	140.0	2.119	3.418	1.687	81.370
154	121	122	40.0	4.0	140.0	1.797	2.398	1.430	59.957
155	122	123	70.0	5.0	140.0	1.114	0.583	0.567	8.335
156	123	124	25.0	4.0	140.0	0.686	0.252	0.546	10.071
157	124	125	45.0	4.0	140.0	0.491	0.244	0.391	5.433
158	125	126	50.0	4.0	140.0	0.373	0.163	0.297	3.262
159	126	127	150.0	3.2	140.0	0.208	0.490	0.258	3.265
160	122	215	25.0	3.2	140.0	0.567	0.524	0.705	20.980
161	215	128	5.0	2.5	140.0	0.567	0.349	1.155	69.809
162	128	129	15.0	3.2	140.0	0.413	0.175	0.514	11.670
163	121	130	270.0	2.5	140.0	0.244	3.967	0.498	14.692
164	129	130	40.0	2.5	140.0	0.229	0.519	0.466	12.981
165	130	127	40.0	2.5	140.0	0.123	0.165	0.250	4.117
166	129	126	45.0	2.5	140.0	0.126	0.194	0.257	4.318
167	128	125	210.0	2.5	140.0	0.057	0.206	0.115	0.981
168	123	131	80.0	5.0	140.0	0.233	0.037	0.119	0.461
169	24	132	55.0	6.5	140.0	2.364	0.515	0.713	9.367
170	132	216	35.0	6.5	140.0	1.857	0.210	0.560	5.986
171	216	133	65.0	6.5	140.0	1.857	0.389	0.560	5.986
172	133	134	30.0	4.0	140.0	1.340	1.044	1.066	34.796
173	134	217	40.0	4.0	140.0	0.681	0.397	0.542	9.930
174	217	135	20.0	4.0	140.0	0.681	0.199	0.542	9.930
175	135	136	45.0	4.0	140.0	0.498	0.173	0.325	3.855
176	136	218	50.0	3.2	140.0	0.155	0.096	0.193	1.914
177	218	141	10.0	3.2	140.0	0.156	0.019	0.193	1.914
178	25	219	80.0	3.2	140.0	0.300	0.387	0.373	6.443
179	219	137	50.0	2.5	140.0	0.300	1.072	0.611	21.440
180	132	220	160.0	3.2	140.0	0.391	1.054	0.486	10.544
181	220	138	60.0	2.5	140.0	0.391	2.105	0.797	35.084
182	134	138	34.0	2.5	140.0	0.445	1.516	0.907	44.597
183	136	139	15.0	4.0	140.0	0.156	0.029	0.124	0.646
184	135	140	60.0	3.2	140.0	0.156	0.115	0.193	1.914
185	133	137	55.0	2.5	140.0	0.206	0.588	0.419	10.696
186	26	144	5.0	3.2	140.0	0.817	0.290	1.015	41.230
187	144	142	55.0	3.2	140.0	0.432	0.697	0.537	12.672
188	142	143	50.0	2.5	140.0	0.159	0.331	0.324	6.623
189	143	148	50.0	2.5	140.0	0.097	0.160	0.198	2.664
190	144	221	60.0	3.2	140.0	0.365	0.558	0.454	9.295
191	221	145	10.0	2.5	140.0	0.365	0.309	0.744	30.930
192	145	146	90.0	4.0	140.0	0.269	0.160	0.214	1.776
193	146	147	30.0	5.0	140.0	0.058	0.001	0.030	0.035
194	142	145	105.0	2.5	140.0	0.078	0.188	0.160	1.793
195	143	146	55.0	3.2	140.0	0.003	0.000	0.004	0.002
196	27	153	238.0	5.0	140.0	0.523	0.509	0.266	2.053
197	153	155	60.0	4.0	140.0	0.157	0.039	0.125	0.658
198	30	154	60.0	10.0	140.0	1.265	0.022	0.161	0.361
199	154	156	171.0	5.0	140.0	0.659	0.539	0.335	3.151
200	154	155	48.0	2.5	140.0	0.115	0.175	0.234	3.639

201	30	152	66.0	5.0	140.0	0.309	0.051	0.158	0.778
202	152	154	40.0	4.0	140.0	-0.181	-0.034	-0.144	-0.851
203	152	153	51.0	4.0	140.0	0.296	0.108	0.235	2.120
204	31	156	120.0	5.0	140.0	0.139	0.021	0.071	0.176
205	29	149	135.0	6.5	140.0	1.178	0.348	0.355	2.576
206	149	150	32.0	5.0	140.0	0.824	0.153	0.420	4.776
207	150	151	164.0	5.0	140.0	0.480	0.287	0.244	1.751
208	151	31	23.0	4.0	140.0	-0.051	-0.002	-0.040	-0.080
209	28	149	162.0	4.0	140.0	0.328	0.415	0.261	2.561
210	150	151	188.0	4.0	140.0	0.248	0.287	0.197	1.527
211	32	157	86.0	6.5	140.0	0.224	0.010	0.068	0.119
212	32	157	152.0	6.5	140.0	0.165	0.010	0.059	0.067
213	35	158	30.0	2.5	140.0	0.091	0.071	0.186	2.368
214	158	159	60.0	2.5	140.0	0.097	0.160	0.198	2.664
215	158	37	30.0	2.5	140.0	-0.065	-0.038	-0.132	-1.265
216	38	161	115.0	2.5	140.0	0.117	0.430	0.238	3.738
217	34	164	70.0	2.5	140.0	0.389	2.431	0.792	34.734
218	164	162	115.0	2.5	140.0	0.117	0.430	0.238	3.738
219	164	163	130.0	2.5	140.0	0.175	1.029	0.357	7.916
220	36	160	45.0	2.5	140.0	0.078	0.079	0.158	1.764
221	33	158	95.0	2.5	140.0	0.077	0.165	0.157	1.734
222	42	165	100.0	2.5	140.0	0.194	0.962	0.396	9.617
223	43	166	195.0	2.5	140.0	0.292	3.976	0.594	20.391
224	41	168	55.0	2.5	140.0	0.204	0.577	0.415	10.495
225	40	167	54.0	5.0	140.0	1.069	0.417	0.544	7.729
226	167	222	125.0	4.0	140.0	0.748	1.478	0.595	11.822
227	222	169	10.0	3.2	140.0	0.748	0.350	0.930	35.045
228	167	168	60.0	2.5	140.0	0.127	0.262	0.258	4.360
229	169	223	10.0	3.2	140.0	0.372	0.096	0.463	9.613
230	223	171	30.0	2.5	140.0	0.372	0.960	0.758	31.986
231	44	170	35.0	2.5	140.0	0.460	1.660	0.937	47.435
232	47	173	77.0	2.5	140.0	0.051	0.062	0.104	0.809
233	171	174	75.0	2.5	140.0	-0.017	-0.008	-0.034	-0.105
234	46	173	140.0	2.5	140.0	0.105	0.427	0.213	3.047
235	49	174	75.0	2.5	140.0	0.173	0.578	0.351	7.710
236	45	172	115.0	4.0	140.0	0.399	0.425	0.318	3.692
237	172	175	75.0	3.2	140.0	0.208	0.245	0.258	3.267
238	175	49	155.0	2.5	140.0	0.052	0.130	0.106	0.840
239	172	48	140.0	2.5	140.0	0.094	0.351	0.192	2.508
240	175	176	150.0	2.5	140.0	0.078	0.265	0.158	1.764
241	51	177	120.0	3.2	140.0	0.194	0.347	0.242	2.890
242	52	224	60.0	3.2	140.0	0.194	0.173	0.242	2.890
243	224	180	60.0	4.0	140.0	0.194	0.058	0.155	0.975
244	50	178	55.0	4.0	140.0	0.386	0.191	0.307	3.479
245	178	179	[illegible]	6.5	140.0	0.491	0.092	0.148	0.509
246	51	178	75.0	6.5	140.0	0.795	0.093	0.240	1.244
247	178	225	[illegible]	5.0	140.0	0.243	0.040	0.124	0.499
248	225	179	35.0	4.0	140.0	0.243	0.057	0.194	1.478
249	179	226	15.0	4.0	140.0	0.151	0.009	0.120	0.609
250	226	53	65.0	3.2	140.0	0.151	0.117	0.187	1.804
251	54	227	125.0	4.0	140.0	0.272	0.227	0.217	1.819
252	227	181	25.0	2.5	140.0	0.272	0.448	0.555	17.939
253	56	182	120.0	6.5	140.0	0.194	0.011	0.059	0.092
254	55	187	[illegible]	5.0	140.0	0.574	0.244	0.292	2.444
255	187	188	[illegible]	5.0	140.0	0.554	0.114	0.282	2.284
256	188	60	30.0	4.0	140.0	0.184	0.026	0.146	0.881
257	55	183	130.0	4.0	140.0	0.320	0.319	0.255	2.453
258	183	240	10.0	3.2	140.0	0.117	0.011	0.145	1.123
259	240	184	60.0	2.5	140.0	0.117	0.299	0.238	3.738
260	183	185	45.0	2.5	140.0	0.009	0.001	0.018	0.031
261	56	186	30.0	3.2	140.0	0.278	0.168	0.346	5.615
262	186	185	25.0	3.2	140.0	0.157	0.048	0.195	1.939
263	185	59	62.0	2.5	140.0	-0.029	-0.023	-0.059	-0.282
264	58	186	40.0	2.5	140.0	0.073	0.062	0.148	1.561
265	57	187	25.0	2.5	140.0	0.115	0.092	0.235	3.664
266	188	189	120.0	2.5	140.0	0.292	2.447	0.594	20.391
267	191	192	14.0	6.5	140.0	0.879	0.021	0.265	1.500
268	192	195	113.0	10.0	140.0	0.763	0.016	0.097	0.141
269	195	197	45.0	10.0	140.0	0.549	0.003	0.077	0.077
270	197	241	10.0	4.0	140.0	0.235	0.014	0.187	1.384
271	241	199	40.0	8.0	140.0	0.235	0.002	0.047	0.047
272	199	228	35.0	3.2	140.0	0.079	0.019	0.099	0.551
273	192	193	60.0	2.5	140.0	0.058	0.062	0.119	1.034
274	195	196	30.0	2.5	140.0	0.058	0.031	0.119	1.034
275	197	198	60.0	6.5	140.0	0.197	0.006	0.059	0.094
276	199	194	90.0	5.0	140.0	0.097	0.008	0.050	0.091
277	190	239	50.0	10.0	140.0	1.404	0.022	0.179	0.439
278	235	236	32.0	5.0	140.0	0.507	0.062	0.258	1.942
279	236	232	97.0	4.0	140.0	0.254	0.155	0.202	1.601
280	232	233	36.0	5.0	140.0	0.347	0.035	0.177	0.962
281	233	234	120.0	4.0	140.0	0.156	0.077	0.124	0.646
282	235	237	50.0	3.2	140.0	0.175	0.118	0.217	2.370
283	237	236	55.0	2.5	140.0	-0.059	-0.058	-0.120	-1.046
284	230	229	50.0	2.5	140.0	0.097	0.133	0.198	2.664
285	230	233	71.0	2.5	140.0	0.003	0.000	0.006	0.004
286	231	232	70.0	4.0	140.0	0.346	0.198	0.275	2.832
287	237	238	83.0	2.5	140.0	0.136	0.412	0.277	4.969
288	61	190	65.0	10.0	140.0	2.880	0.108	0.367	1.657
289	190	191	18.0	8.0	140.0	1.320	0.021	0.263	1.158

290	191	239	30.0	10.0	140.0	0.383	0.001		
291	239	235	24.0	10.0	140.0	1.593	0.013	0.049	0.039
292	235	231	118.0	10.0	140.0	0.914	0.019	0.203	0.553
293	231	228	18.0	4.0	140.0	0.312	0.042	0.104	0.159
294	228	242	14.0	3.2	140.0	0.197	0.042	0.249	2.347
295	242	230	50.0	3.2	140.0	0.197	0.149	0.245	2.974
296	18	4	90.0	2.5	140.0	0.046	0.060	0.245	2.974
297	169	95	90.0	3.2	140.0	-0.013	-0.002	0.094	0.666
298	95	170	25.0	2.5	140.0	-0.013	-0.002	-0.016	-0.019
								-0.026	-0.064

THE RELATIVE CHANGE IN FLOWRATE FROM PRIVIOUS TRIAL= 0.00297

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	143.774	123.770	20.00
2	0.21390	143.616	122.890	20.73
3	0.58330	143.330	122.240	21.09
4	0.33060	143.195	122.710	20.49
5	0.15560	142.117	125.510	16.61
6	0.00000	139.481	125.150	14.33
7	0.00000	136.935	125.790	11.14
8	0.19440	134.401	125.030	9.37
9	0.19440	134.318	125.290	9.03
10	0.33060	134.227	124.860	9.37
11	0.13610	134.179	124.310	9.87
12	0.58330	134.037	122.430	11.61
13	0.33060	133.947	124.410	9.54
14	0.17500	133.878	123.530	10.35
15	0.77780	133.787	125.600	8.19
16	0.19440	133.739	124.420	9.32
17	0.29170	133.585	127.570	6.02
18	0.38890	143.255	122.810	20.45
19	0.13610	141.715	125.130	16.59
20	0.35000	141.603	126.340	15.26
21	0.09720	141.555	125.950	15.60
22	0.00000	140.593	126.000	14.59
23	0.00000	135.314		
24	0.09720	138.906	127.870	11.04
25	0.35000	138.662	128.650	10.01
26	0.19440	137.296	129.650	7.65
27	0.00000	135.825	128.210	7.61
28	0.19440	135.787	128.310	7.48
29	0.29170	135.719	128.630	7.09
30	0.48610	135.473	128.970	6.50
31	0.87500	134.933	128.730	6.20
32	0.00000	134.135	125.750	8.39
33	0.09720	141.268	125.810	15.46
34	0.05830	141.244	126.280	14.96
35	0.15560	141.174	126.950	14.22
36	0.03890	141.163	126.590	14.57
37	0.11670	141.141	126.240	14.90
38	0.05830	141.120	126.500	14.62
39	0.00000	140.025	126.330	13.69
40	0.00000	138.644	127.760	10.88
41	0.19440	138.542	127.650	10.89
42	0.19440	138.404	127.120	11.28
43	0.05830	138.338	126.730	11.61
44	0.29170	138.062	127.280	10.78
45	0.00000	136.729	127.570	9.16
46	0.11670	136.406	127.070	9.34
47	0.23330	136.041	127.410	8.63
48	0.19440	135.953	127.000	8.95
49	0.15560	135.929	126.930	9.00
50	0.00000	133.850	126.500	7.35
51	0.19440	133.752	126.370	7.38
52	0.52500	133.481	126.990	6.49
53	0.44720	133.446	127.100	6.35
54	0.19440	133.031	125.810	7.22
55	0.00000	137.420	128.540	8.88
56	0.11670	137.317	128.430	8.89
57	0.09720	137.267	127.050	10.22
58	0.15560	137.211	126.690	10.52
59	0.29170	137.123	126.660	10.46
60	0.58330	137.035	128.240	8.80
61	0.07780	134.699	128.170	6.53
62	0.19440	142.465	121.840	20.62
63	0.15560	142.622	122.820	19.80
64	0.09720	132.315	123.270	9.05
65	0.09720	131.137	122.770	8.37
66	0.19440	130.289	122.560	7.73
67	0.09720	130.086	122.550	7.54
68	0.17500	129.751	122.380	7.37
69	0.25280	129.342	122.000	7.34
70	0.07780	129.297	123.170	6.13
71	0.09720	129.057	122.780	6.28

72	0.19440	129.296	123.180	6.12
73	0.21390	129.409	123.230	6.18
74	0.36940	129.828	122.400	7.43
75	0.25280	131.023	122.270	8.75
76	0.07780	131.258	123.280	7.96
77	0.35000	129.975	123.470	6.50
78	0.66110	129.554	122.650	6.90
79	0.29170	130.047	121.590	8.46
80	0.52500	129.592	122.390	7.20
81	0.09720	129.841	121.980	7.86
82	0.15560	129.819	123.330	6.49
83	0.07780	132.772	126.730	6.04
84	0.13610	132.339	126.010	6.33
85	0.09720	132.010	125.600	6.41
86	0.17500	131.945	125.130	6.82
87	0.35000	131.905	125.110	6.80
88	0.15560	132.635	126.510	6.12
89	0.11670	132.079	125.890	6.19
90	0.09720	131.941	125.900	6.04
91	0.11670	131.605	125.600	6.00
92	0.09720	131.781	125.100	6.68
93	0.07780	132.529	126.450	6.08
94	0.15560	131.733	125.390	6.34
95	0.00000	136.400		
96	0.15560	131.932	125.910	6.02
97	0.23330	134.173	125.720	8.45
98	0.19440	133.019	125.550	7.47
99	0.09720	134.226	125.310	8.92
100	0.35000	132.070	125.150	6.92
101	0.19440	131.434	124.620	6.81
102	0.09720	131.353	124.870	6.48
103	0.19440	130.920	124.900	6.02
104	0.29170	131.005	123.850	7.16
105	0.25280	130.465	122.620	7.84
106	0.19440	132.739	122.840	9.90
107	0.17500	132.997	123.620	9.38
108	0.29170	132.820	124.390	8.43
109	0.19440	133.216	125.730	7.49
110	0.36940	133.567	127.300	6.27
111	0.38890	133.513	127.360	6.15
112	0.68060	133.544	127.450	6.09
113	0.19440	137.679	126.000	11.68
114	0.33060	134.514	125.460	9.05
115	0.09720	134.206	125.470	8.74
116	0.48610	133.805	126.370	7.44
117	0.48610	134.017	125.760	8.26
118	0.17500	133.494	125.050	8.44
119	0.17500	133.494	124.790	8.70
120	0.11670	133.905	125.610	8.29
121	0.07780	136.133	126.260	9.87
122	0.11670	133.735	126.210	7.52
123	0.19440	133.151	126.390	6.76
124	0.19440	132.899	126.150	6.75
125	0.17500	132.655	125.700	6.95
126	0.29170	132.491	125.820	6.67
127	0.33060	132.001	125.000	7.00
128	0.09720	132.861	126.160	6.70
129	0.05830	132.685	126.200	6.49
130	0.35000	132.166	125.200	6.97
131	0.23330	133.114	126.300	6.81
132	0.11670	138.391	128.630	9.76
133	0.31110	137.792	131.150	6.64
134	0.21390	136.749	129.790	6.96
135	0.11670	136.152	129.010	7.14
136	0.09720	135.979	128.720	7.26
137	0.50560	137.203	130.200	7.00
138	0.83610	135.231	128.800	6.43
139	0.15560	135.950	128.700	7.25
140	0.15560	136.037	128.790	7.25
141	0.15560	135.864	128.610	7.25
142	0.19440	136.392	129.410	6.98
143	0.05830	136.061	129.420	6.64
144	0.01940	137.089	130.050	7.04
145	0.17500	136.204	129.640	6.56
146	0.21390	136.061	129.450	6.61
147	0.05830	136.060	129.980	6.08
148	0.09720	135.901	128.800	7.10
149	0.68060	135.372	127.990	7.38
150	0.09720	135.219	128.160	7.06
151	0.77780	134.932	128.610	6.32
152	0.19440	135.424	128.750	6.67
153	0.66110	135.316	128.870	6.45
154	0.31110	135.451	129.440	6.01
155	0.27220	135.276	129.060	6.22
156	0.79720	134.912	128.600	6.31
157	0.38890	134.125	126.980	7.14
158	0.13610	141.103	126.000	15.10
159	0.09720	140.944	125.470	15.47
160	0.07780	141.084	126.820	14.26

161	0.11670	140.690	126.780	13.91
162	0.11670	138.382	126.780	11.60
163	0.17500	137.783	126.780	11.00
164	0.09720	138.812	125.530	13.28
165	0.19440	137.442	127.880	9.56
166	0.29170	134.361	127.280	7.08
167	0.19440	138.226	128.060	10.17
168	0.33060	137.965	127.800	10.16
169	0.38890	136.398	128.510	7.89
170	0.44720	136.402	127.420	8.98
171	0.38890	135.343	127.420	7.92
172	0.09720	136.304	126.630	9.67
173	0.15560	135.979	127.210	8.77
174	0.15560	135.350	127.210	8.14
175	0.07780	136.059	126.840	9.22
176	0.07780	135.794	126.780	9.01
177	0.19440	133.405	126.650	6.76
178	0.44720	133.659	126.890	6.77
179	0.58330	133.567	127.550	6.02
180	0.19440	133.250	127.210	6.04
181	0.27220	132.356	125.350	7.01
182	0.19440	133.021	126.980	6.04
183	0.19440	137.101	128.440	8.66
184	0.11670	136.791	128.630	8.16
185	0.19440	137.100	127.780	9.32
186	0.19440	137.149	127.820	9.33
187	0.13610	137.176	127.410	9.77
188	0.07780	137.062	127.700	9.36
189	0.29170	134.615	127.800	6.81
190	0.15560	134.591	128.140	6.45
191	0.05830	134.570	128.010	6.56
192	0.05830	134.549	127.710	6.84
193	0.05830	134.487	127.970	6.52
194	0.09720	134.506	128.130	6.38
195	0.15560	134.533	127.310	7.22
196	0.05830	134.502	127.360	7.14
197	0.11670	134.530	128.250	6.28
198	0.19720	134.524	128.340	6.18
199	0.05830	134.514	128.400	6.11
200	0.00000	134.815		
201	0.00000	139.715		
202	0.00000	136.439		
203	0.00000	140.549		
204	0.00000	129.648		
205	0.00000	132.677		
206	0.00000	132.410		
207	0.00000	133.938		
208	0.00000	134.105		
209	0.00000	133.025		
210	0.00000	131.209		
211	0.00000	135.092		
212	0.05830	133.774	126.210	7.56
213	0.29170	135.131	126.340	8.79
214	0.00000	139.550		
215	0.00000	133.210		
216	0.00000	138.181		
217	0.00000	136.351		
218	0.00000	135.883		
219	0.00000	138.275		
220	0.00000	137.336		
221	0.00000	136.532		
222	0.00000	136.749		
223	0.00000	136.302		
224	0.00000	133.309		
225	0.00000	133.619		
226	0.00000	133.558		
227	0.00000	132.804		
228	0.19440	134.495	127.790	6.70
229	0.09720	134.171	126.900	7.27
230	0.09720	134.304	127.100	7.20
231	0.15560	134.537	128.160	6.38
232	0.25280	134.338	127.960	6.38
233	0.19440	134.304	127.710	6.59
234	0.15560	134.226	127.600	6.63
235	0.09720	134.556	128.190	6.37
236	0.19440	134.494	127.890	6.60
237	0.09720	134.437	127.460	6.98
238	0.13610	134.025	127.090	6.93
239	0.19440	134.569	128.590	5.98
240	0.00000	137.090		
241	0.00000	134.516		
242	0.00000	134.453		

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER	ROUGHNESS	RATE	TOTAL LENGTH	COST

(CMS)		(/M(RS)	(METERS)	(RS)
25.0	130.0	55.00	100.0	5500.00
20.0	130.0	40.00	9425.0	377000.00
15.0	130.0	30.00	8300.0	249000.00
12.5	130.0	25.00	4522.0	113050.00
10.0	140.0	17.80	3033.0	53987.40
8.0	140.0	12.70	2583.0	32804.10
6.5	140.0	9.70	3067.0	29749.90
5.0	140.0	7.00	3238.0	22666.00
4.0	140.0	4.70	2961.0	13916.70
3.2	140.0	4.15	3859.0	16014.85
2.5	140.0	4.10	6140.0	25174.00
		TOTAL COST=		938862.95

SCHEME 5

RAJPUR GROUP OF VILLAGES RURAL WATER SUPPLY SCHEME,KANPUR

THIS SYSTEM HAS ONE OVER HEAD TANK

THIS SYSTEM HAS 86 PIPES, 60 JUNCTIONS, 26 LOOPS AND 1 FIXED GRADE NODE

THESE ARE THE RESULTS FOR THE FLOWS IN PIPES

THE FOLLOWING RESULTS ARE OBTAINED AFTER 6 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	90.0	20.0	130.0	22.389	0.261	0.713	2.899	111.00
2	1	2	150.0	20.0	130.0	20.444	0.367	0.651	2.450	
3	2	11	100.0	10.0	130.0	3.198	0.231	0.407	2.307	
4	11	12	55.0	10.0	130.0	2.823	0.101	0.359	1.831	
5	12	13	35.0	8.0	130.0	2.323	0.132	0.462	3.783	
6	2	3	40.0	20.0	130.0	15.331	0.057	0.488	1.437	
7	3	4	30.0	20.0	130.0	14.697	0.040	0.468	1.329	
8	4	5	50.0	15.0	130.0	13.538	0.232	0.766	4.635	
9	5	6	50.0	15.0	130.0	13.090	0.218	0.741	4.355	
10	6	7	40.0	15.0	130.0	12.544	0.161	0.710	4.024	
11	7	8	40.0	15.0	130.0	12.136	0.151	0.687	3.785	
12	8	9	60.0	15.0	130.0	11.809	0.216	0.668	3.599	
13	9	10	20.0	15.0	130.0	10.654	0.059	0.603	2.974	
14	10	15	30.0	15.0	130.0	9.455	0.072	0.535	2.384	
15	15	40	70.0	15.0	130.0	9.823	0.179	0.556	2.559	
16	40	41	117.0	15.0	130.0	8.274	0.218	0.468	1.862	
17	41	42	1000.0	15.0	130.0	7.194	1.437	0.407	1.437	
18	42	43	175.0	10.0	130.0	2.366	0.231	0.301	1.320	
19	43	44	35.0	8.0	130.0	1.370	0.050	0.273	1.423	
20	44	45	160.0	6.5	130.0	0.926	0.303	0.279	1.895	
21	42	50	155.0	12.5	130.0	4.440	0.221	0.362	1.429	
22	50	51	20.0	6.5	130.0	0.699	0.023	0.211	1.126	
23	51	44	130.0	6.5	130.0	0.334	0.037	0.101	0.287	
24	50	49	80.0	12.5	130.0	2.962	0.054	0.241	0.675	
25	49	48	40.0	8.0	130.0	1.673	0.082	0.333	2.060	
26	48	47	60.0	8.0	130.0	1.479	0.098	0.294	1.639	
27	47	45	180.0	6.5	130.0	0.545	0.128	0.164	0.710	
28	47	46	100.0	6.5	130.0	0.545	0.071	0.164	0.709	
29	49	46	140.0	6.5	130.0	0.900	0.252	0.271	1.797	
30	43	51	105.0	6.5	130.0	0.218	0.014	0.066	0.130	
31	12	14	170.0	5.0	140.0	0.375	0.189	0.191	1.110	
32	45	45	30.0	4.0	140.0	0.279	0.057	0.222	1.896	
33	4	13	90.0	4.0	140.0	0.421	0.366	0.335	4.071	
34	15	16	700.0	8.0	130.0	0.777	0.348	0.155	0.498	
35	2	17	125.0	8.0	130.0	1.916	0.331	0.381	2.648	
36	17	18	30.0	8.0	130.0	1.800	0.071	0.358	2.358	
37	18	19	70.0	6.5	130.0	1.022	0.159	0.308	2.272	
38	19	23	240.0	6.5	130.0	0.897	0.428	0.270	1.784	
39	23	28	90.0	4.0	140.0	0.392	0.321	0.312	3.567	
40	18	22	30.0	5.0	140.0	0.653	0.093	0.333	3.100	
41	28	22	35.0	5.0	140.0	0.403	0.044	0.205	1.269	
42	20	21	90.0	3.2	140.0	0.125	0.115	0.155	1.276	
43	22	24	180.0	5.0	140.0	0.516	0.361	0.263	2.006	
44	24	23	55.0	3.0	140.0	0.120	0.089	0.169	1.615	
45	3	17	140.0	5.0	140.0	0.509	0.273	0.259	1.953	
46	4	22	160.0	5.0	140.0	0.613	0.442	0.312	2.761	
47	5	25	145.0	4.0	140.0	0.323	0.362	0.257	2.498	
48	6	25	105.0	5.0	140.0	0.421	0.144	0.214	1.376	
49	25	26	45.0	3.2	140.0	0.244	0.198	0.303	4.405	
50	5	27	70.0	5.0	140.0	0.202	0.025	0.103	0.352	
51	27	26	50.0	5.0	140.0	0.110	0.006	0.056	0.114	
52	26	24	35.0	4.0	140.0	0.104	0.011	0.083	0.305	
53	9	29	220.0	8.0	130.0	1.030	0.185	0.205	0.839	
54	10	30	140.0	8.0	130.0	1.075	0.127	0.214	0.907	
55	29	28	50.0	4.0	140.0	0.198	0.050	0.157	1.007	
56	30	31	40.0	6.5	140.0	0.782	0.048	0.236	1.206	
57	31	32	90.0	5.0	140.0	0.532	0.191	0.271	2.120	
58	30	29	30.0	5.0	140.0	-0.082	-0.002	-0.042	-0.067	
59	40	39	60.0	8.0	130.0	1.299	0.077	0.258	1.289	
60	39	35	120.0	8.0	130.0	0.933	0.084	0.186	0.698	
61	41	38	80.0	6.5	130.0	0.580	0.064	0.175	0.795	
62	39	38	140.0	4.0	140.0	0.242	0.204	0.192	1.458	
63	38	37	100.0	4.0	140.0	0.321	0.247	0.256	2.472	
64	35	36	65.0	4.0	140.0	0.480	0.338	0.382	5.207	
65	36	37	35.0	4.0	140.0	0.179	0.029	0.142	0.835	
66	36	34	75.0	4.0	140.0	0.177	0.061	0.141	0.816	
67	35	33	95.0	4.0	140.0	0.202	0.100	0.161	1.049	
68	32	33	45.0	4.0	140.0	0.371	0.145	0.295	3.229	

69	33	34	100.0	3.2	140.0	0.198	0.300	0.247	3.000
70	26	32	55.0	3.2	140.0	0.214	0.191	0.267	3.467
71	34	60	35.0	3.2	140.0	0.125	0.045	0.155	1.275
72	37	60	60.0	3.2	140.0	0.125	0.077	0.155	1.277
73	1	52	1127.0	10.0	130.0	1.944	1.034	0.248	0.918
74	52	53	200.0	8.0	130.0	1.944	0.544	0.387	2.721
75	53	54	240.0	8.0	130.0	0.784	0.122	0.156	0.506
76	53	58	70.0	8.0	130.0	0.966	0.052	0.192	0.744
77	53	59	160.0	4.0	140.0	0.194	0.156	0.155	0.975
78	54	55	120.0	4.0	140.0	0.201	0.125	0.160	1.038
79	58	57	35.0	5.0	140.0	0.562	0.062	0.286	2.351
80	57	56	60.0	5.0	140.0	0.284	0.040	0.144	0.662
81	57	55	130.0	4.0	140.0	0.182	0.112	0.144	0.859
82	58	56	160.0	5.0	140.0	0.306	0.122	0.156	0.762
83	7	27	90.0	4.0	140.0	0.283	0.176	0.225	1.956
84	56	55	80.0	3.2	140.0	0.104	0.072	0.129	0.900
85	13	16	790.0	8.0	130.0	1.348	1.091	0.268	1.381
86	13	15	600.0	8.0	130.0	1.271	0.742	0.253	1.237

THE RELATIVE CHANGE IN FLOWRATE FROM PRIVIOUS TRIAL= 0.00086

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	110.739	99.000	11.74
2	0.00000	110.372	98.585	11.79
3	0.12500	110.314	98.570	11.74
4	0.12500	110.274	99.335	10.94
5	0.12500	110.043	99.575	10.47
6	0.12500	109.825	99.725	10.10
7	0.12500	109.664	99.875	9.79
8	0.12500	109.512	99.735	9.78
9	0.12500	109.296	99.855	9.44
10	0.12500	109.237	100.000	9.24
11	0.37500	110.141	99.180	10.96
12	0.12500	110.040	100.040	10.00
13	0.12500	109.908	100.120	9.79
14	0.37500	109.852	99.115	10.74
15	0.12500	109.165	100.655	8.51
16	2.12500	108.817	100.655	8.16
17	0.62500	110.041	98.635	11.41
18	0.12500	109.970	98.325	11.64
19	0.12500	109.811	97.410	12.40
20	0.12500	109.877	98.920	10.96
21	0.12500	109.762	98.475	11.29
22	0.50000	109.833	99.570	10.26
23	0.62500	109.383	98.675	10.71
24	0.50000	109.471	99.935	9.54
25	0.50000	109.680	100.840	8.84
26	0.25000	109.482	100.270	9.21
27	0.37500	109.488	100.000	9.49
28	0.37500	109.062	98.090	10.97
29	0.75000	109.112	100.040	9.07
30	0.37500	109.110	99.980	9.13
31	0.25000	109.062	99.615	9.45
32	0.37500	108.871	98.050	10.82
33	0.37500	108.726	97.805	10.92
34	0.25000	108.426	97.845	10.58
35	0.25000	108.825	98.695	10.13
36	0.12500	108.487	98.235	10.25
37	0.37500	108.458	97.875	10.58
38	0.50000	108.705	98.595	10.11
39	0.12500	108.909	100.005	8.90
40	0.25000	108.986	100.390	8.60
41	0.50000	108.769	99.475	9.29
42	0.38889	107.331	98.475	8.86
43	0.77778	107.100	97.910	9.19
44	0.77778	107.050	98.000	9.05
45	1.74999	106.747	98.000	8.75
46	1.16666	106.804	98.365	8.44
47	0.38889	106.875	97.850	9.02
48	0.19444	106.973	97.380	9.59
49	0.38889	107.056	97.525	9.53
50	0.77778	107.110	96.325	10.78
51	0.58333	107.087	100.295	6.79
52	0.00000	109.705	99.465	10.24
53	0.00000	109.160	97.575	11.59
54	0.58333	109.039	98.440	10.60
55	0.48611	108.914	97.060	11.85
56	0.48611	108.986	97.245	11.74
57	0.09722	109.026	97.285	11.74
58	0.09722	109.108	96.970	12.14
59	0.19444	109.004	99.965	9.04
60	0.25000	108.381	97.805	10.58

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEME

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
20.0	130.0	40.00	310.0	12400.00
15.0	130.0	28.08	1477.0	41474.16
12.5	130.0	24.00	235.0	5640.00
10.0	130.0	19.00	1457.0	27683.00
8.0	130.0	16.50	3465.0	57172.50
6.5	130.0	10.50	1265.0	13282.50
5.0	140.0	7.60	1315.0	9994.00
4.0	140.0	5.60	1495.0	8372.00
3.2	140.0	4.10	465.0	1906.50
		TOTAL COST=		177924.66

THE FOLLOWING CHANGES IN SYSTEM DATA ARE MADE

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS
27	47	45	180.0	5.0	140.0
31	12	14	170.0	4.0	140.0
34	15	16	700.0	6.5	130.0
38	19	23	240.0	5.0	140.0
46	4	22	160.0	4.0	140.0
53	9	29	220.0	6.5	130.0
57	31	32	90.0	4.0	140.0
60	39	35	120.0	6.5	130.0
62	39	38	140.0	3.2	140.0
77	53	59	160.0	3.2	140.0
78	54	55	120.0	3.2	140.0
82	58	56	160.0	4.0	140.0
85	13	16	790.0	6.5	130.0
3	2	11	100.0	8.0	130.0
4	11	12	55.0	8.0	130.0
35	2	17	125.0	6.5	130.0
59	40	39	60.0	6.5	130.0
61	41	38	80.0	5.0	140.0
64	35	36	65.0	3.2	140.0
65	36	37	35.0	3.2	140.0
66	36	34	75.0	3.2	140.0
20	44	45	160.0	5.0	140.0
54	10	30	140.0	6.5	130.0
6	2	3	40.0	15.0	130.0
7	3	4	30.0	15.0	130.0
73	1	52	1127.0	8.0	130.0
29	49	46	140.0	5.0	140.0

THE FOLLOWING RESULTS ARE OBTAINED AFTER 2 TRIALS

PIPE NO.	NODE NUMBERS		LENGTH (METERS)	DIAMETER (CMS)	ROUGHNESS	FLOWRATE (LIT/SEC)	HEAD LOSS (METERS)	VELOCITY (M/SEC)	HL/1000	FIXED GRADE (METERS)
1	0	1	90.0	20.0	130.0	22.389	0.261	0.713	2.899	111.00
2	1	2	150.0	20.0	130.0	20.444	0.367	0.651	2.450	
3	2	11	100.0	8.0	130.0	2.875	0.562	0.572	5.615	
4	11	12	55.0	8.0	130.0	2.500	0.239	0.497	4.335	
5	12	13	35.0	8.0	130.0	2.000	0.100	0.398	2.868	
6	2	3	40.0	15.0	130.0	15.859	0.249	0.897	6.213	
7	3	4	30.0	15.0	130.0	15.037	0.169	0.851	5.630	
8	4	5	50.0	15.0	130.0	14.014	0.247	0.793	4.941	
9	5	6	50.0	15.0	130.0	13.552	0.232	0.767	4.644	
10	6	7	40.0	15.0	130.0	12.965	0.172	0.735	4.290	
11	7	8	40.0	15.0	130.0	12.546	0.161	0.710	4.025	
12	8	9	60.0	15.0	130.0	12.114	0.226	0.686	3.773	
13	9	10	20.0	15.0	130.0	11.028	0.063	0.624	3.171	
14	10	15	30.0	15.0	130.0	9.778	0.076	0.553	2.537	
15	15	40	70.0	15.0	130.0	9.891	0.181	0.560	2.592	
16	40	41	117.0	15.0	130.0	8.438	0.226	0.477	1.931	
17	41	42	1000.0	15.0	130.0	7.194	1.437	0.407	1.437	
18	42	43	175.0	10.0	130.0	2.316	0.222	0.295	1.269	
19	43	44	35.0	8.0	130.0	1.272	0.043	0.253	1.241	
20	44	45	160.0	5.0	140.0	0.756	0.651	0.385	4.069	
21	42	55	155.0	12.5	130.0	4.489	0.226	0.366	1.458	
22	50	51	20.0	6.5	130.0	0.579	0.016	0.174	0.793	
23	51	44	130.0	6.5	130.0	0.262	0.024	0.079	0.182	
24	50	48	80.0	12.5	130.0	3.133	0.060	0.255	0.749	
25	49	48	40.0	8.0	130.0	2.059	0.121	0.410	3.021	
26	48	47	60.0	8.0	130.0	1.864	0.151	0.371	2.517	
27	47	45	180.0	5.0	140.0	0.514	0.359	0.262	1.932	
28	47	46	100.0	6.5	130.0	0.961	0.203	0.290	2.028	
29	49	46	140.0	5.0	140.0	0.685	0.475	0.349	3.392	
30	43	51	105.0	6.5	130.0	0.266	0.020	0.080	0.188	
31	12	14	170.0	4.0	140.0	0.375	0.560	0.298	3.292	
32	46	45	30.0	4.0	140.0	0.480	0.156	0.382	5.194	
33	4	13	30.0	4.0	140.0	0.488	0.483	0.388	5.364	
34	15	16	700.0	6.5	130.0	0.988	1.493	0.298	2.134	
35	2	17	125.0	6.5	130.0	1.711	0.738	0.516	5.900	
36	17	18	30.0	8.0	130.0	1.782	0.069	0.354	2.315	
37	18	19	70.0	6.5	130.0	0.825	0.107	0.249	1.528	
38	19	23	240.0	5.0	140.0	0.700	0.846	0.356	3.527	
39	23	28	90.0	4.0	140.0	0.342	0.249	0.272	2.769	
40	18	20	30.0	5.0	140.0	0.832	0.146	0.424	4.858	
41	20	22	35.0	5.0	140.0	0.582	0.088	0.296	2.506	
42	20	21	90.0	3.2	140.0	0.125	0.115	0.155	1.276	
43	22	24	180.0	3.2	140.0	0.193	0.331	0.251	1.840	
44	24	23	55.0	3.0	140.0	0.267	0.391	0.377	7.107	
45	3	17	140.0	5.0	140.0	0.696	0.489	0.355	3.492	
46	4	22	160.0	4.0	140.0	0.411	0.623	0.327	3.893	
47	5	25	125.0	4.0	140.0	0.336	0.390	0.268	2.691	
48	6	25	105.0	5.0	140.0	0.442	0.158	0.225	1.505	

49	25	26	45.0	3.2	140.0	0.278	0.253	0.346	5.618
50	[illegible]	27	70.0	5.0	140.0	0.306	0.053	0.156	0.762
51	27	26	50.0	5.0	140.0	0.246	0.025	0.125	0.508
52	26	24	35.0	4.0	140.0	0.274	0.064	0.218	1.843
53	9	29	220.0	6.5	130.0	0.961	0.446	0.290	2.028
54	10	30	140.0	6.5	130.0	1.126	0.380	0.339	2.718
55	29	28	50.0	4.0	140.0	0.298	0.107	0.237	2.149
56	30	31	40.0	6.5	140.0	0.664	0.036	0.200	0.890
57	31	32	90.0	4.0	140.0	0.414	0.355	0.329	3.946
58	30	29	30.0	5.0	140.0	0.087	0.002	0.044	0.074
59	40	39	60.0	6.5	130.0	1.204	0.185	0.363	3.078
60	39	35	120.0	6.5	130.0	0.897	0.214	0.270	1.785
61	41	38	80.0	5.0	140.0	0.743	0.315	0.378	3.940
62	39	38	140.0	3.2	140.0	0.182	0.358	0.226	2.555
63	38	37	100.0	4.0	140.0	0.425	0.415	0.338	4.150
64	35	36	65.0	3.2	140.0	0.341	0.531	0.424	8.173
65	36	37	35.0	3.2	140.0	0.094	0.026	0.116	0.746
66	36	34	75.0	3.2	140.0	0.122	0.092	0.152	1.224
67	35	33	95.0	4.0	140.0	0.306	0.215	0.244	2.261
68	32	33	45.0	4.0	140.0	0.303	0.100	0.241	2.219
69	33	34	100.0	3.2	140.0	0.234	0.408	0.291	8.082
70	28	32	55.0	3.2	140.0	0.264	0.281	0.329	5.112
71	34	60	35.0	3.2	140.0	0.106	0.033	0.132	0.947
72	37	60	60.0	3.2	140.0	0.144	0.099	0.178	1.648
73	1	52	1127.0	8.0	130.0	1.944	3.067	0.387	2.721
74	52	53	200.0	8.0	130.0	1.944	0.544	0.387	2.721
75	53	54	240.0	8.0	130.0	0.738	0.109	0.147	0.452
76	53	58	70.0	8.0	130.0	1.012	0.057	0.201	0.812
77	53	59	160.0	3.2	140.0	0.194	0.463	0.242	2.891
78	54	55	120.0	3.2	140.0	0.155	0.227	0.192	1.889
79	56	57	35.0	5.0	140.0	0.697	0.123	0.355	3.504
80	57	56	60.0	5.0	140.0	0.383	0.069	0.195	1.155
81	57	55	130.0	4.0	140.0	0.217	0.156	0.173	1.198
82	58	56	160.0	4.0	140.0	0.217	0.192	0.173	1.200
83	7	57	90.0	4.0	140.0	0.315	0.214	0.250	2.379
84	56	55	80.0	3.2	140.0	0.114	0.086	0.142	1.081
85	13	16	790.0	6.5	130.0	1.137	2.189	0.343	2.771
86	13	15	600.0	8.0	130.0	1.226	0.695	0.244	1.158

THE RELATIVE CHANGE IN FLOWRATE FROM PRIVIOUS TRIAL= 0.00420

THESE ARE THE RESULTS FOR THE PRESSURES AT JUNCTION NODES

JUNCTION NO.	DEMAND (LIT/SEC)	GRADE LINE (METERS)	ELEVATION (METERS)	PRESSURE (METERS)
1	0.00000	110.739	99.000	11.74
2	0.00000	110.372	98.585	11.79
3	0.12500	110.123	98.570	11.55
4	0.12500	109.954	99.335	10.62
5	0.12500	109.707	99.575	10.13
6	0.12500	109.475	99.725	9.75
7	0.12500	109.303	99.875	9.43
8	0.12500	109.142	99.735	9.41
9	0.12500	108.916	99.855	9.06
10	0.12500	108.852	100.000	8.85
11	0.37500	109.810	99.180	10.63
12	0.12500	109.572	100.040	9.53
13	0.12500	109.471	100.120	9.35
14	0.37500	109.012	99.115	9.90
15	0.12500	108.776	100.655	8.12
16	2.12500	107.283	100.655	6.63
17	0.62500	109.634	98.635	11.00
18	0.12500	109.565	98.325	11.24
19	0.12500	109.459	97.410	12.05
20	0.12500	109.419	98.920	10.50
21	0.12500	109.304	98.475	10.83
22	0.50000	109.331	99.570	9.76
23	0.62500	108.611	98.675	9.94
24	0.50000	109.000	99.935	9.07
25	0.50000	109.317	100.840	8.48
26	0.25000	109.064	100.270	8.79
27	0.37500	109.089	100.000	9.09
28	0.37500	108.362	98.090	10.27
29	0.75000	108.469	100.040	8.43
30	0.37500	108.472	99.980	8.49
31	0.25000	108.436	99.615	8.82
32	0.37500	108.081	98.050	10.03
33	0.37500	107.981	97.805	10.18
34	0.25000	107.573	97.845	9.73
35	0.25000	108.196	98.695	9.50
36	0.12500	107.665	98.235	9.43
37	0.37500	107.639	97.875	9.76
38	0.50000	108.054	98.595	9.46
39	0.12500	108.410	100.005	8.41
40	0.25000	108.595	100.390	8.20
41	0.50000	108.369	99.475	8.89
42	0.38889	106.932	98.475	8.46

43	0.77778	106.710	97.910	8.80
44	0.77778	106.666	98.000	8.67
45	1.74999	106.015	98.000	8.02
46	1.16666	106.171	98.365	7.81
47	0.38889	106.374	97.850	8.52
48	0.19444	106.525	97.380	9.14
49	0.38889	106.646	97.525	9.12
50	0.77778	106.706	96.325	10.38
51	0.58333	106.690	100.295	6.39
52	0.00000	107.672	99.465	8.21
53	0.00000	107.128	97.575	9.55
54	0.58333	107.020	98.440	8.58
55	0.48611	106.793	97.060	9.73
56	0.48611	106.879	97.245	9.63
57	0.09722	106.949	97.285	9.66
58	0.09722	107.071	96.970	10.10
59	0.19444	106.666	99.965	6.70
60	0.25000	107.540	97.805	9.73

THE FOLLOWING IS THE COST STATEMENT OF THE SCHEM

DIAMETER (CMS)	ROUGHNESS	RATE (/M(RS)	TOTAL LENGTH (METERS)	COST (RS)
20.0	130.0	40.00	240.0	9600.00
15.0	130.0	28.08	1547.0	43439.76
12.5	130.0	24.00	235.0	5640.00
10.0	130.0	19.00	175.0	3325.00
8.0	130.0	16.50	2592.0	42768.00
6.5	130.0	10.50	2620.0	27510.00
5.0	140.0	7.60	1535.0	11666.00
4.0	140.0	5.60	1480.0	8288.00
3.2	140.0	4.10	1060.0	4346.00
		TOTAL COST=		156582.76